NATURE

No. 4333 SATURDAY, NOVEMBER 15, 1952 Vol. 170

CONTENTS

	Page
Industrial Management in the Welfare State	811
Present Position of Meteorology	814
The World of Touch. By Prof. John Cohen	815
Text-book of Silvicultural Systems. By Prof. H. G. Champion, C.I.E.	816
Reactivity of Free Radicals : Faraday Society Discussion in Toronto. By Prof. H. W. Melville, F.R.S.	819
The Human Blood Groups. By Dr. F. Stratton	821
Energetics of Sensory Effects. By Dr. J. A. B. Gray	823
Obituaries:	
Dr. W. E. Gye, F.R.S. By Dr. J. Craigie, O.B.E., F.R.S.	825
Miss K. C. Boswell. By Miss F. C. Miller	825
News and Views	826
Brewing Industry Research Foundation	830
Royal Society of Canada: Meeting at Laval University, Quebec. By Dr. B. W. Sargent	832
Employment Problems of Disabled Youth in Glasgow	833
Enzymic Degradation of Pectic Acid and the Complex Nature of Polygalacturonase. By Audrey Ayres, J. Dingle, A. Phipps, W. W. Reid and G. L. Solomons	834
Streaming Potential and Electro-osmosis. By Dr. Horace E. Rose and G. Moss; K. L. Nash and N. W. Lister	836
Letters to the Editors:	
Temperature of the Interior of the Earth.—Prof. J. A. Jacobs	838
Effect of Water Vapour on Explosions of Carbon Monoxide.—D. E. Hoare and Dr. A. D. Walsh	838
Poisoning of Oxide Cathode Emission by Oxygen.—Dr. A. A. Shepherd	839
Coloured 'Perspex' for Darkroom Lights.—L. A. T. Ballard	840
Enzymic Splitting and Synthesis of Glutathione.—P. J. Fodor, A. Miller and Dr. H. Waelsch	841
Essential Role of Thiol Groups in Carboxylase.—Prof. A. O. M. Stoppani, A. S. Actis, Dr. J. O. Deferrari and Dr. E. L. Gonzalez	842
A New Method for the Bioassay of Cholinesterase Inhibitors.—S. Callaway, P. Dirnhuber and K. M. Wilson	843
Pyrolysis of Dissolved Nitrocellulose.—R. D. Smith	844
Paper Chromatographic Separation of Barbituric Acids.—Dr. Arne Grieg	845
Specificity of Vitamin B_{12} for *Euglena*.—Dr. William J. Robbins, Annette Hervey and Mary E. Stebbins	845
Nucleic Acids of Rickettsiæ.—Dr. G. R. Wyatt and Dr. S. S. Cohen	846
Symbiosis in *Ptilinus pectinicornis* L.—E. A. Parkin	847
Occurrence of Malonic Acid in Plants.—Miss L. E. Bentley	847
Variation in Leaf Form in *Callitriche intermedia*.—Herbert Jones	848
Lowered Liver Vitamin A Reserves in Avian Coccidiosis.—Alan W. Davies	849
Spread of Pigment in Sheep Skin Autografts.—Dr Margaret H. Hardy, Dr. A. S. Fraser and Dr. B. F. Short	849
A Lipoprotein Precursor of Sclerotin in the Cockroach Cuticle.—S. R. A. Malek	850
Packed Red-Cell Volume in the Tropics.—Dr. G. R. Wadsworth	851
Reversal of the Heart-beat in Tunicates.—Dr. R. H. Millar	851
Level of National Intelligence.—Dr. John D. Nisbet	852

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

INDUSTRIAL MANAGEMENT IN THE WELFARE STATE

IN its report for the year ending March 31, 1952, the Council of the British Institute of Management once again stressed the way uncertainty regarding future Government financial assistance handicaps the work of the Institute. The original five-year arrangement with the Government has now almost expired, and although the present Government has assured a deputation of its continued support of the purposes for which the Institute was established in 1948, the grant-in-aid of £50,000 eventually included in the Board of Trade estimates for 1952–53 is regarded as inadequate, notwithstanding the continuing growth of subscription income, to enable the Institute to carry out the full functions of a central institute of management. Since much of the Institute's work is of the nature of a public service to British industry as a whole, the Council makes a strong claim for a further and continuing contribution towards the cost of such service from public funds.

The completion of the merger with the Institute of Industrial Administration strengthens that claim, and it is also supported by the evidence in the reports of the Anglo-American Council on Productivity's teams on management accounting and on education for management. Elsewhere, the decisive contribution which management could make towards increasing productivity, and remedying the deficiency in Britain of men trained for management is widely recognized. It should be remembered, too, that when, in accordance with the recommendation of the Baillieu report six years ago the British Institute of Management was established, it was supported not only by Government funds but also by industry. The Council of the Institute believes that with even a fifty per cent increase in the present grant of £50,000 the Institute could meet the many and important demands now being made upon it.

What is possibly even more important is that the Institute should no longer be compelled to organize its work on a year-to-year basis. Such conditions are inimical to effective work in education and still more in research. The first fruits of the Institute's work in this latter field reinforce the claims of the Institute for the quite small sums which are required to place its work on an adequate and a permanent basis.

If the British Institute of Management's Field Research Group further develops its scrutiny of technical and managerial methods and skills and their adaptation to present requirements, it will be essential for the Institute to be assured of continued financial support. The value of a case study of an organization in its social environment as a complex indivisible unit has recently been demonstrated strikingly by the publication of a volume containing three such studies by J. F. Scott and R. P. Lynton. The Institute is not, of course, alone in making such investigations. Recent studies carried out, for example, by the Acton Society Trust, by the National Institute of Industrial Psychology or the Tavistock

Institute of Human Relations in association with the Human Factors Panel of the Committee on Industrial Productivity and by the Department of Social Science of the University of Liverpool, all emphasize the importance of such investigations and their bearing on productivity and the economic future of Great Britain.

The study of joint consultation in British industry published earlier this year (cf. *Nature*, **170**, 254; 1952) noted a tendency for managers with high technical qualifications to pay insufficient attention to human factors in administration; nevertheless, it brought out the extent to which the whole problem of communication within industry is largely unsolved and that, while the responsibility for action and initiative may rest with management, all the faults do not lie on that side. New attitudes require to be developed on both sides. Dr. W. H. Scott's study* of human relations in three Merseyside firms largely corroborates the evidence obtained in the inquiry conducted earlier by the National Institute of Industrial Psychology's research team. This study, to which Sir George Schuster once again contributes a foreword, is an extension of work originally promoted by the Human Factors Panel. It provides further evidence that the working of a joint consultative system is extricably interwoven with, and conditioned by, the whole pattern of personal relations and informal structure in a particular firm, and by the pattern of deep-seated loyalties and suspicions which inevitably exist. No form of joint consultative machinery can accordingly fit every firm indiscriminately, and no system of joint consultation will work unless the total situation in the firm is right.

There is clear enough warning in Dr. Scott's book of the danger of attempting to create the right kind of co-operative spirit in industry by compulsory prescription of any standard form of joint consultative committee; but even more emphatically is that warning given by the Acton Society Trust's latest study, "The Worker's Point of View"†. This discussion of 'reporting back' based on a study in a coalfield gives a startling picture of the failure of the joint consultative machinery provided by statute, both to give employees an opportunity of having a say in the running of their firm or industry, and to supply them with sufficient background knowledge to ensure that their contribution is useful and relevant. In actual fact, so far from arousing a new sense of participation, the provision made under the Nationalization Acts has proved quite ineffective for both purposes. The dominant factor in the situation revealed by this study is not so much ignorance as the existence of an appalling range of positive misconception and misinformation. The very conditions in which joint consultation can function have still to be created.

To some extent this has already become apparent outside industry, through such incidents as the rejection by mine-workers of Italian workers. But the Acton Society Trust's study brings out clearly three factors, or rather attitudes, which dominate the whole situation: a persistent fear of the return of unemployment; a deep suspicion of all those in authority, who are thought to be idle or venal when not cruel or malicious; and a belief that the public regards the miner as an inferior type of human being and almost a social outcast. Joint consultation and the effective absorption of information are scarcely possible while such attitudes persist, and nothing less than an intensive programme of education and re-education on a national scale will serve. The practical problem is two-fold—whether from the point of view of joint consultation or morale; to provide more factual information, and to dispel these suspicions.

The Acton Society Trust does not suggest that there have been no failures to pass on effectively information which has been supplied; but it rightly insists on the necessity of restoring confidence in management—a point equally stressed in Dr. Scott's investigation. But it is the loss of human relationships in the nationalized industries that is responsible for much of the difficulty, and here, as appears more fully in Dr. Joseph Goldstein's study of the government of British trade unions*, the trade unions themselves must bear part of the responsibility. The question may fairly be raised whether, from the point of view of human relations, the whole administrative structure of some nationalized industries, such as the railways, is fundamentally wrong.

The picture revealed by the Acton Society Trust's study is disquieting, not simply from the picture of ignorance, misconception and misinformation which it reveals but still more because so often managements appear not to have thought out clearly either what employees should know or how to give them this information, and have made little attempt to put into effect a definite policy. Much trouble, it is true, has been due to failure on the part of members of consultative committees to pass on the information which has been given them. Even here, however, the question may be raised whether management is entitled to think it has discharged its responsibilities when it has given information to these committees.

That view is supported by Dr. Scott's study, which emphasizes the dependence of effective consultation not merely on the social relations existing in the factory but also on the extent to which management has taken the trouble to secure that the attitudes and behaviour of departmental managers and supervisors are in harmony with policy, and correlated with the employees' approval of both higher management and the general conditions existing in the firm. Like the earlier investigation of the National Institute of Industrial Psychology, his study emphasizes the way in which the pattern set by senior management, and in particular the higher executive, tends to be reflected throughout an organization. Moreover, both studies conclude that where management's leadership is

* Industrial Leadership and Joint Consultation: a Study of Human Relations in Three Merseyside Firms. By Dr. W. H. Scott. Pp. xii+210. (Liverpool: University Press of Liverpool, 1952.) 12*s.* 6*d.*

† The Worker's Point of View: a Discussion of 'Reporting Back' based on a Study in a Coalfield. (Nationalised Industry Series, 11.) Pp. iv+32. (London: Acton Society Trust, 1952.) 2*s.*

* The Government of British Trade Unions: a Study of Apathy and the Democratic Process in the Transport and General Workers Union. By Dr. Joseph Goldstein. Pp. 300. (London: George Allen and Unwin, Ltd., 1952.) 25*s.* net.

paternal, employees tend to be concerned mainly with the personal advantages they can derive from joint consultation. They agree also that the status problems of representatives and the apathy of the rank and file are serious obstacles to successful joint consultation; joint consultation tends to be more successful where it has been introduced by the modification of existing arrangements, such as management – shop steward procedures.

Sir George Schuster, in his foreword to Dr. Scott's book, expresses his belief that university departments are specially fitted to conduct the type of research in this field which, both by its methods and personnel, inspires the confidence essential for enlisting the active interest and collaboration of those concerned. That belief is substantiated by the approach to this study indicated by Dr. Scott, and by the account he gives of the methods used. No claim is advanced that the results described are more than preliminary, or that they show more than the interdependence of the various sectors of social relationships in an industrial organization and the very limited contribution which the introduction of formal joint consultation can make to the improvement of industrial relations. Nevertheless, they do something more than stress the cardinal importance of real leadership in general. The problems which further work should seek to clarify in this complex situation are indicated. The characteristics of the behaviour of a variety of leaders, and the associated attitudes and behaviour of the subordinates for whom they are responsible, at various levels in the everyday industrial situation, require description. Again, while morale and productivity may be less closely linked than has often been suggested, the important outstanding problem here is to determine whether there is a particular type of social structure within which both high morale and high productivity co-exist.

We are, in fact, rapidly increasing our knowledge of the ways in which change may be achieved, and this only increases the importance of developing our systematic knowledge of the directions in which change should proceed. Dr. Scott rightly urges that a fuller understanding of the nature of effective leadership, and of the factors which mould the behaviour of leaders, is needed if our increasing knowledge of the procedures which will facilitate change is to be used to the best advantage. But those procedures will only be used with confidence as the directions which change should take become clearly defined.

Accordingly, studies concerning the community and the cultural milieu of leaders are specially important, and this is emphasized at one particular point where these studies of Dr. Scott, the National Institute of Industrial Psychology and the Acton Society Trust touch Dr. Goldstein's study of British trade unions. The two former remark on the way in which a good trade union – management relationship facilitated joint consultation, and Dr. Scott, recognizing further the complication which inter-union rivalry can introduce, notes that the attempt to solve such problems will require an analysis of the structure and functioning of the trade union movement such as Dr. Goldstein has, in part, attempted. Quite as explicitly, the Acton Society Trust recognizes that in this matter of communications and leadership the sole responsibility does not rest on management: there is the further more specific question of immediate interest to the unions themselves of how far industrial democracy can be made a reality except on a basis of good communications.

To this question Dr. Goldstein's story of apathy and the democratic process in the Transport and General Workers Union gives a very perturbing answer. His study shows that the lack of interest of the rank-and-file of the workers revealed by these studies of leadership and joint consultation in specific firms is paralleled in one of the largest trade unions of Great Britain. At the same time, he demonstrates beyond question the way in which both the method of conveying public information and the determination of what information is relevant are matters of vital and direct concern to the unions as well as to industry.

The unrealistic view of industrial democracy prevalent in the Union studied by Dr. Goldstein is probably the most disturbing feature of his book. The domination of the Union by a small group which may be quite unrepresentative has dangers which are obvious, though within the Union they appear not to be realized. To some extent that position is due to the very high proportion of members who are automatically deprived of the opportunity of holding any office by a rule which makes office conditional on membership in good standing for at least two years.

Dr. Goldstein's study lends support to the view that, while the rules and constitution of this Union make it in theory fully democratic, the apathy of the ordinary workers has converted it into an oligarchy liable to be captured and used for purposes alien to the wishes of the majority, notwithstanding that members are, in general, alert and inquisitive persons. 'Branch' activities have failed to develop within the membership the social skills that are best expressed in an individual's capacity to receive communications from others and to respond to their attitudes and ideas, so as to promote well-informed participation in the common tasks of the democratic co-operation of the Union.

Nothing could better express the connexion between the management studies already discussed and the trade unions than this conclusion of Dr. Goldstein. He recognizes that the Union has many great achievements to its credit, and that it has trained many leaders who have served the community well. What is lacking is that tradition of democracy, which only everyday experience, custom and practice can build within the Union, and Dr. Goldstein maintains that it is the responsibility of the Union to widen the scope of its appeal to the rank-and-file beyond the horizon of mere wage increases or the improvement of conditions at a particular factory.

Part of the importance of this study lies in its revelation of the plain fact that the Union has failed to secure the active interest of most of its members. To that extent the Union faces the same problem as

industrial management faces in joint consultation, and the response of the Unions to that challenge cannot be a matter of indifference to industry or to the nation as a whole. The self-contained attitude of at any rate some trade unions is a barrier to the development of wider loyalties in keeping with the need of the times. That is not stated explicitly by Dr. Goldstein, but a short-sighted insistence on the maintenance of vested power is likely to be the biggest obstacle to the trade unions accepting their responsibility of training the individual, through democratic participation, to adapt himself intelligently to the ever-changing personal relationships created by the demands of democracy in a highly industrialized economy.

If the trade unions do not respond to that challenge, democracy itself is endangered, for in the long run they alone can supply the tradition of democracy which is required for the growth of industrial democracy. If they accept the challenge, they will, as all these studies show, be faced with problems of communication, consultation and co-operation essentially similar to those which management faces in industry. In that lies the final reason for continued and adequate support by the Government of the British Institute of Management. It is not simply that the Institute is already making valuable investigations in this field—and that Messrs. J. F. Scott and R. P. Lynton provide a substantial basis for confidence in this question of securing co-operation and loyalty. It is rather that the British Institute of Management, as an independent body, with which trade unions are already associated, as well as industry, is doing unique work. It provides opportunities for managers and trade union leaders to meet in an atmosphere free from negotiation, and to explore informally many problems that are of common interest. In consultation with the trade union advisory committee, it is considering the desirability of including the field of trade union structure and working as a part of management training. Only such an independent body, the staff and methods of which command confidence, is in a position to provide whatever disinterested advice the trade unions require when they address themselves to the task of adapting their organization to meet the new demands and problems of the social welfare State. No more foolish economy could well be imagined than to jeopardize the efficient working of a body which serves such well-attested needs.

PRESENT POSITION OF METEOROLOGY

Compendium of Meteorology

Edited by Thomas F. Malone. Pp. ix+1334. (Boston, Mass.: American Meteorological Society, 1951.) 12 dollars.

THE preface of the "Compendium of Meteorology" states that the purpose of the book is to take stock of the present position of meteorology, to summarize the knowledge won by research in recent years, and to indicate lines for future study and research. The "Compendium", in fact, gives a broad survey of the state of knowledge in 1950 of physical and dynamical meteorology, of methods of weather forecasting, and of some aspects of climatology, applied meteorology and meteorological instrumentation.

The book has been compiled primarily for the professional meteorologist and other specialists in atmospheric physics. It must be made clear for the benefit of any who may be misled by the title that it does not include a collection of climatological data, physical tables, or tables for meteorological computers. It is not, on the whole, a text-book for new students of meteorology. Some articles cover the whole of their particular subject in a way very useful to readers with little previous knowledge; but many articles are very compressed, cover relatively recent developments only, and assume a thorough acquaintance with the bases of the subject.

There are a hundred and eight articles written by a hundred and two authors assembled into twenty-five sections. A few articles are by two or more authors. Seventy-seven of the authors are now working in the United States, though many of these, such as J. Bjerknes, B. Haurwitz and H. G. Booker, are of European origin. Eleven authors are now working in Britain. The great majority of authors are internationally known experts in their respective fields. The majority of the articles conclude with a list of problems on which research is most urgently needed and with extensive bibliographies.

The titles of the sections are, with brief notes, as follows: composition of the atmosphere (one article, chemical composition); radiation (three articles); meteorological optics (three articles, includes physics of visibility); atmospheric electricity (six articles); cloud physics (seven articles, includes artificial stimulation of precipitation); the upper atmosphere (twelve articles, atmosphere above the tropopause); cosmical meteorology (two articles, relations between solar phenomena and terrestrial weather changes); dynamics of the atmosphere (ten articles, includes meteorological thermodynamics, turbulence, and atmospheric tides); general circulation (three articles, summary of observations as well as theories); mechanics of pressure systems (six articles, pressure temperature and wind structure of depressions and anticyclones); local circulations (four articles, sea breezes, orographic effects on wind, air currents of thunderclouds); observations and analysis (three articles, distribution of observing stations, methods of plotting and analysing weather charts); weather forecasting (nine articles, short- and long-period forecasting, vertification of forecasts); tropical meteorology (four articles); polar meteorology (three articles, one on the Antarctic is very comprehensive on the aerological side); climatology (six articles, applications of meteorological information in planning, past climates, microclimatology); hydrometeorology (two articles, application of rainfall data in water supply and control of river flow); marine meteorology (four articles, exchange of energy between air and sea, ocean waves); biological and chemical meteorology (three articles, distribution of biological organisms by the atmosphere, human bioclimatology, measurement of atmospheric composition and other chemical problems); atmospheric pollution (one article); clouds, fog, and aircraft icing (five articles); meteorological instruments (two

articles, almost exclusively on instruments for upper-air observation); laboratory investigations (three articles, use of models in meteorological research); radio meteorology (four articles, radar cloud echoes, refraction of high-frequency electromagnetic waves, use of location of atmospherics in weather forecasting); and microseisms (two articles, causes of microseisms and their application in forecasting).

The book shows that, as is natural, the greatest progress has been made in those parts of meteorology in which experiment is possible. Experiments in cloud physics, stimulated by the scientific desire to understand the processes of condensation of water vapour and formation of precipitation, the attraction of artificial precipitation and artificial cloud dispersal, and the need to minimize ice accretion on aircraft have led to great progress in that subject. Development in radio apparatus has given the meteorologist much better instruments than before 1939 for examining cloud structure and measuring pressure, wind and temperature in the free atmosphere.

Though techniques have improved and the number of stations increased, we learn that the accuracy of observation of some elements is not high enough for numerical forecasting and that over much of the equatorial regions and southern hemisphere stations are too sparse for scientific needs. Disappointment at the failure of the increase in the amount of information to provide more accurate forecasts of general weather is strongly expressed. The writers on synoptic meteorology and the general circulation are clear that more effort needs to be devoted to study of the circulation as a whole and to basic research in meteorological physics, at the expense of study of local circulations and development of empirical forecasting techniques.

The articles on meteorological dynamics and thermodynamics provide excellent summaries of these subjects and show very clearly their immense difficulties. The differential equations can only be solved for simplified states of steady motion or for first-order perturbations from those states, and the observed effects are given in the equations as the relatively small differences between two large terms the values of which are not known with sufficient accuracy for calculation of the differences. In his article on numerical prediction J. G. Charney is hopeful about allowing for radiation and condensation of water vapour but pessimistic about the turbulent transfer of heat and momentum.

At the end of his article on the forecast problem, H. C. Willett calls for the establishment of an international centre for global meteorological research. In this connexion it is of interest to see that the first number (April 1952) of the *Bulletin of the World Meteorological Organization* shows that attention is being given to this proposal. One of the features of the developments of the past fourteen years has been the growing realization of the value of meteorological knowledge in civil and military planning and in the control of industrial and agricultural processes. The articles by C. S. Durst, H. E. Landsberg and W. C. Jacobs, R. Geiger and E. W. Hewson on these matters deserve study by planners, engineers and agriculturists as well as meteorologists.

Considered as a picture of developments since 1939 the book is very complete, and there seem to be few omissions. More might have been said on condensation trails in the articles on cloud physics; and the subject of turbulence in clear air at great heights, to which much effort has been devoted during the past five years, is not mentioned. Very few misprints have been noted. The type and illustrations are very clear and the binding good. The editors have evidently taken much care to ensure uniformity of notation in the mathematical articles. The index contains about twelve hundred entries and seems very complete.

Meteorologists and all to whom meteorological knowledge is important will be grateful to the American Meteorological Society and the Geophysics Research Division of the United States Air Force, which supported the preparation in financial and other ways, for the production of this magnificent book.

THE WORLD OF TOUCH

Psychology and Art of the Blind

By Prof. G. Révész. Translated from the German by Dr. H. A. Wolff. Pp. xxiv+338. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1950.) 42*s.* net.

As the title of Prof. G. Révész's book seems to suggest, there are here really two books combined into one. The first deals with the fundamental theory of haptics ("the impressions conveyed by the tactile and kinematic sense"); the second deals with the æsthetic experience in haptic perception and with the creative activity of the blind. The work as a whole opens up a field of investigation for haptics comparable in its way with the fields of optics and acoustics. Besides being an important original contribution to psychology, it will doubtless be of considerable interest to the student of æsthetics. Erudite, clear and critical, it carries the mark of the mature scholar.

The method employed is chiefly that of searching phenomenological analysis, supplemented where appropriate by experiment. The experiments are not of the 'stream-lined' variety favoured by many of the American psychologists. They are ingeniously simple and usually conclusive. The Continental tradition of phenomenology has never taken root in Britain, and among psychologists in the United States, with very few exceptions, the very word 'phenomenologist' is almost a term of abuse. Yet, on studying such a work as this, one cannot help feeling that psychology in these countries has been impoverished as a result. Only two of the eighty references cited by Prof. Révész are to American sources; and in a well-known symposium on perception (edited by Blake and Ramsey), published in the United States in 1951, more than five hundred references are cited; but Prof. Révész does not appear among them, although he has devoted a large proportion of a long and distinguished career to research on perception. These signs are disturbing.

One of the main conclusions reached by Prof. Révész involves a rejection of the alleged universal applicability of *Gestalt* principles to all modes of perception. It had been more or less tacitly assumed that the principles that are probably valid for vision hold also for touch, although the world of touch has been left almost unexplored by the *Gestalt* theorists. Prof. Révész argues that haptic and optic space are autonomous, and that the first is just as real psycho-

logically as the second. The world of those born blind is just as spatial as the world of the sighted but in a phenomenologically different way. In haptic space we proceed from structure to form; in visual space we proceed from form to structure. Apprehension of form means the appreciation of a unity of elements fused in a total impression. Apprehension of structure means consciously acquiring knowledge of the spatial and temporal relations of the perceived object. Prof. Révész derives a number of principles which he believes govern haptic perception in a distinctive way.

Much of the second part of the book is taken up with a careful study of the life-histories and artistic achievements of a number of blind sculptors. Here one must pay a tribute to the immense effort expended by the author in collecting and checking his data. He concludes that the æsthetic 'function' of the haptic sense is very limited. The blind are unable to apprehend objects as individual entities because haptic perception merely gives type images devoid of individuality. This may explain why they have no desire to finger objects of art or to learn details of their form and structure.

The foregoing indicates the kind of issue raised by Prof. Révész. The reader interested in almost any aspect of human perception or in the nature of æsthetic experience is bound to learn a great deal from his book. He had also better prepare himself to unlearn, because he will encounter a challenge to many of his preconceptions. JOHN COHEN

TEXT-BOOK OF SILVICULTURAL SYSTEMS

Silvicultural Systems

By Dr. R. S. Troup. (Oxford Manuals of Forestry.) Second edition, edited by E. W. Jones. Pp. xv+216+43 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 25*s*. net.

TROUP'S "Silvicultural Systems", published in 1928, has long been recognized both as one of the best forestry text-books in the English language and the best survey in any language of the subject with which it deals. Changes in the methods of handling forests, however desirable, can only be a very slow process, as variation in future treatment is unavoidably largely circumscribed by what has been done in the past. A consequence of this fact is that although changed practices inevitably become necessary with increase of experience and the progress of knowledge, a book such as this does not quickly become out of date. It is therefore not surprising that even after twenty-four years the editor of the new edition finds that he can accept almost unchanged the greater part of the text, and that, apart from a few relatively minor amendments, changes in view and in practice can mostly be dealt with in an additional final chapter. Dr. E. W. Jones has among British foresters an unrivalled knowledge of the silviculture and silvicultural practices of western Europe, derived from repeated visits, particularly to France and Switzerland, and he has also first-hand knowledge of some of the silvicultural problems of tropical forests. As, also, he was on Troup's staff teaching silviculture and carrying out research in the subject, he was obviously in an exceptionally good position to bring Troup's book in line with current thought and practice.

In his preface, Dr. Jones enumerates the main changes he has made, and, except for modifying Troup's rather unqualified acceptance of the view that the selection system with all-aged crops gives timber inferior to that obtained with the more or less uniform (even-aged) crops, it is clear that his original contribution is concentrated in the new Chapter 20, "Developments of the Last Twenty Years". This is, indeed, a masterly and valuable summary of recent trends of thought in this field. Dr. Jones, man of science that he is, is very careful to keep in view the economic and practical considerations that must always play a large part in choosing between possible alternatives, and I only disagree with him in his reluctance to accept the view that supervision of uneven-aged forest is more difficult than that of more or less even-aged forests worked under the other systems; above all, when the technical standard of the staff is not first-class.

This chapter brings out the greatly increased importance now attached to the maintenance of soil fertility, leading to a growing preference for less regularity both in age and size, and in species, and to the maintenance of the canopy, avoiding clear or very heavy fellings at all times. I miss at this point an assessment of the alleged merits of periodically admitting light and warmth to the soil, as there are certain conditions where the claim is made that undesirable accumulation of raw humus occurs without it; there are also conditions in the tropics where, with appropriate treatment, any damage that may ensue from such exposure may be more than compensated, both economically and silviculturally, by the quick establishment of a better new crop.

The second important point made is that there is now a demand for more freedom of action to adapt current work in the forest to economic changes, the nature and direction of which cannot be predicted. The feeling is very general that any operation which ties the hands of the forest manager for a long period is to be avoided: this is just one more of the reasons that is giving a bias in favour of woods of mixed ages and species. It might perhaps also have been noted how generally the stress has shifted from getting each area unit of a forest into a form fitting into a preconceived pattern under a silvicultural system, to getting it into a condition in which it is producing the maximum growth in quantity and quality. Attention is very rightly directed to the new factor of forest genetics to be kept in mind.

The five pages devoted to natural regeneration in tropical forests (pp. 200–4), together with p. 207 on the enrichment of tropical forest and scrub, while perhaps not entirely up to date, give a very fair idea of the position. The merits and demerits of clear felling with artificial regeneration, notably with agricultural crops ('taungya') as a method of quickly bringing a mainly unproductive forest into more or less full production, will appear to many to be of sufficient importance for fuller discussion; such drastic measures might quite well only be necessary once, when the forest is first brought under intensive working.

Dr. Jones has done forestry another considerable service in undertaking this revision, and it can confidently be predicted that the new edition will meet most requirements for another twenty years.

H. G. CHAMPION

Chemical Kinetics

By Prof. Keith J. Laidler. (International Chemical Series.) Pp. ix+408. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 47*s*.

THERE has been a real need for a modern and intelligible book on chemical kinetics, and the present volume seems to provide such a book. It includes what may be called the classical material, in which it is pleasing to find that the contributions of those who laid the foundations of the subject are adequately recognized. The style is clear and concise, so that a large amount of information is presented in a readable form. Adequate references to literature are given, not confined to American publications.

All the important topics are covered, and special mention may be made of the clear accounts of the theory of absolute reaction-rates, which many students find difficult, and of chain reactions. Photochemical processes are included, and there is a good summary of polymerization. The experimental methods are briefly explained. It might have been mentioned on p. 34 that 'Pyrex' glass often gives anomalous results; the point is brought out later, but it could have been emphasized, since some apparent contradictions in results are due to this fact, as is mentioned on p. 52. There are useful short tables of results, and a selection of problems at the end of each chapter will be useful to students and teachers.

The chapter on catalysis is to some extent rather confused by the contradictory results of different workers, and in such cases it might have been better in an elementary work to wait until the subject is a little more clarified in such parts. They are more suited to a report than a text-book. All the same, it may be hoped that students beginning research may be stimulated by such contradictions to undertake work in the field. The book is one which can be warmly recommended as giving a modern and adequate account of its subject within its standard.

J. R. P.

Substances naturelles de synthèse

Préparations et méthodes de laboratoire. Collection publiée sous la direction de Dr. Léon Velluz. Vol. 3. Par J. Mathieu, P. Poirier, A. Petit et Dr. L. Velluz. Pp. 156. (Paris: Masson et Cie., 1951.) 1,750 francs.

THE third volume of this series follows the same plan as the two previous volumes (see *Nature*, 169, 169; 1952). It gives details, taken from current chemical literature, for the small-scale laboratory preparation of the following compounds: *dl*-glutamic acid from methyl acrylate and sodio ethyl acetamidomalonate (Snyder, Steckleton and Lewis, *J. Amer. Chem. Soc.*, 1945); *dl*-3: 4-dihydroxyphenylalanine from piperonal (Barry, Mattocks and Hartung, *J. Amer. Chem. Soc.*, 1948); œstradiol from the acetate of dehydroandrosterone (Wilds and Djerassi, *J. Amer. Chem. Soc.*, 1946); *dl*-ornithine from acrylonitrile and ethyl acetamidomalonate (Albertson and Archer, *J. Amer. Chem. Soc.*, 1945); and thiamin (vitamin B_1) (Gravin, *J. Chim. App. U.R.S.S.*, 1943). There are many additional notes on the preparation of intermediates, and on a variety of topics connected with the syntheses, including the Michael reaction, aliphatic nitroso compounds, bromination of 3-keto-steroids, syntheses of equilenin and œstrone, the Stobbe reaction, cyanoethylation, the synthesis of pyrimidines and thiazoles, the preparation of alcohols from amines, and oxythiamine.

Two sections deal at some length with the preparation of thiazoles and benzthiazoles, and with the synthesis of α-amino-acids. These articles tabulate many thiazoles and amino-acids, with their methods of preparation and the relevant references. There is finally a short article on the determination of melting points, and the book is completed by a table of contents, and author and compound indexes to the experimental sections.

W. BAKER

Treatise on Powder Metallurgy

By Dr. Claus G. Goetzel. Vol. 3: Classified and Annotated Bibliography. Pp. xxiv+899. (New York: Interscience Publishers, Inc., 1952.) 22 dollars.

THIS is the third, and last, volume of Dr. C. G. Goetzel's "Treatise" (see *Nature*, 168, 133; 1951), and its appearance crowns a magnificent achievement. It consists of a classified and annotated bibliography and comprises, with indexes, etc., 899 pages. After a short preface, with acknowledgments and a section on the use of the bibliography, there is a full contents table giving the sub-divisions of chapters and sections. The bibliography follows the same order and divisions of subject as that in the preceding volumes. The literature survey comprises 5,535 separate references, each accompanied by a short annotation indicating the main subject and sufficient to indicate the necessity or otherwise of further study. References are complete to January 1, 1950, and careful search has failed to disclose any important gap.

The patent index cites 6,330 patents, including American and British, and many French, German and other Continental countries. There is a complete subject index, and the very full name index differentiates between literature and patents by using Arabic numerals for the former and italic numerals for the latter.

Now that the complete treatise on powder metallurgy is available, it is possible to appreciate the magnitude of Dr. Goetzel's work and to assess, in part at least, the nature of the contribution he has made to all present and future workers in this field. There can be no question that this "Treatise" will provide the standard work on the subject for many years to come and will be indispensable in every reference library on metallurgy.

H. W. GREENWOOD

Preparation of Organic Intermediates

By Prof. David Allen Shirley. Pp. x+328. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 48*s*. net.

ALTHOUGH the range of organic chemicals offered by chemical manufacturers is ever increasing, more often than not a certain intermediate which is needed for a synthesis is not available, and the laboratory worker has to resort to its preparation. Usually, he first refers to "Organic Syntheses" to see whether preparative details are given in one of the several volumes of the series. If not, he has to search the original literature and often make a judicious selection. This book contains specific preparative information on more than five hundred useful organic compounds. The preparations listed are all taken directly from the literature, but the author is to be congratulated on the selection of compounds included and the preparative methods adopted. The criteria which determined his choice

of intermediates were as follows: the compounds are not available commercially or, if available, are relatively expensive; they are useful intermediates for the synthesis of other chemicals, or their method of preparation serves as an example of a generally useful type of organic reaction; the starting materials are commonly available (in the United States) or, if not, their preparation is described in "Organic Syntheses" or elsewhere in the book.

All the preparations are on a convenient and useful laboratory scale. The inclusion of some catalyst preparations and certain precautionary notices concerning hazards are commendable features. In addition to a molecular formula and general index, there is a "type of reaction" index which is valuable and which serves to indicate the wide range of reactions covered.

This book is a worthy companion volume to "Organic Syntheses". J. Idris Jones

Artificial Fibres

By R. W. Moncrieff. Pp. x+313. (London: National Trade Press, Ltd., 1950.) 25*s*. net.

FIBRES from groundnuts, others from seaweed, fibres long known such as those from the cuprammonium process, celanese and viscose, others more modern such as nylon, 'Terylene', and vicara, lesser-known ones such as those made from glass or from polythene; fibres manufactured, spun, woven, stretched, regenerated, dyed, their strength tested; fibres examined, analysed, identified and their molecular structure investigated; staple fibres, lustrous fibres, anti-crease fibres; all are described or discussed by the author—himself a master craftsman—in this interesting and informative book.

Besides being clearly and singularly well written, the book is made additionally attractive by its 112 illustrations, many of which are in half-tone. The thirty-one chapters are grouped to make five parts severally headed as follows: the structure and properties of fibres; regenerated cellulosic and alginic fibres; regenerated protein fibres; synthetic fibres; and processing. The greater part of the text will be easily understood and enjoyed by the ordinary reader. The sections appealing only to the expert are well done and supported by abundant references to the literature. A perusal fully bears out the publisher's claim that the book affords a thorough up-to-date survey of modern synthetic fibres, and it should appeal to all in any way concerned with these new and promising materials.

The Hardness of Metals

By D. Tabor. (Monographs on the Physics and Chemistry of Materials.) Pp. ix+176. (Oxford: Clarendon Press; London: Oxford University Press, 1951.) 15*s*. net.

STANDARD text-books satisfactorily describe the various techniques of hardness testing and critically discuss their relative advantages and disadvantages in practice. They do not, however, provide any clear understanding of what is meant by 'hardness'; nor do they explain the hardness behaviour of metals in terms of any of the well-understood physical properties. The omission is rectified by the book under review. Over a period of several years the author has studied the problems of contact between solid surfaces and, finding the existing theory of deformation by indenters quite inadequate, he has proceeded to build up a satisfactory treatment in terms of the formal theory of plasticity using only very simple mathematical methods. No reader can fail to be impressed by the thorough way in which this has been done, for light is thrown on almost every aspect of hardness behaviour. Meyer's Law is derived from the stress-strain curve; the relationship between Brinell hardness and ultimate tensile strength is explained, and many empirical relationships deduced from practical experience are given a physical basis.

Dynamic or rebound hardness and the factors determining the area of contact between solids are discussed in the final two chapters.

This book is clearly written and illustrated and can be warmly recommended to all those who are interested in the hardness of metals. It is without doubt the most important work on the subject to have appeared for many years.

A. G. Quarrell

The Old Place

By C. C. Vyvyan. Pp. 190. (London: Museum Press, n.d.) 15*s*. net.

IN an age of ever-increasing statistics and sociological studies there is a danger that the history of our times may become intelligible only to those of our successors who have familiarized themselves with the requisite techniques. Yet shades of emphasis and the nuances of everyday life are still difficult to express mathematically and need the eye and expressive powers of the artist before they can be transmitted to others elsewhere. In "The Old Place", Miss C. C. Vyvyan would be the last to claim that she had written a precise account of what the Second World War had meant to those who lived in large country homes. She could claim to have recorded faithfully her part in the struggle to 'keep up' at least some of the standards of one fine old country house, and especially its garden. This simple account of a determined and not unsuccessful effort to restore the house and garden to a state of beauty after years of requisition by military and other authorities is one which was worth the telling; it deserves readers, now and hereafter.

The British Pharmaceutical Codex, 1949

Supplement 1952. (Published by direction of the Council of the Pharmaceutical Society of Great Britain.) Pp. xii+148. (London: Pharmaceutical Press, 1952.) 25*s*. net.

THE continual appearance of new drugs makes it difficult to keep the books of reference up to date. The "British Pharmacopœia" of 1948 was followed by an addendum in 1951, and the "Codex" of 1949 is followed by a supplement in 1952. This supplement contains new general monographs, dealing with twenty-two drugs now officially described for the first time in Great Britain, and fourteen drugs already described in the addendum to the British Pharmacopœia. There are also fourteen old monographs which have been amended because the drugs appeared in the addendum.

The new drugs include amidone, aureomycin, cyanocobalamin (vitamin B_{12}), dapsone, decamethonium, diethylcarbamazine (Hetrazan), gallamine (Flaxedil), gammabenzene, lucanthone (Miracil *D*), mephenesin, solapsone (Sulphetrone) and troxidone (Tridione). It is good to have official standards and names for all these drugs, and reliable paragraphs on their actions and uses. The Codex Revision Committee is to be congratulated.

REACTIVITY OF FREE RADICALS

FARADAY SOCIETY DISCUSSION IN TORONTO

THE first full meeting of the Faraday Society held outside the United Kingdom took place in Toronto during September 8–9. Owing to the generosity and hospitality of Canadian chemists, a strong party of British chemists was able to participate in the meeting and to see something at first hand of Canadian achievements in chemistry during visits to university, government and industrial laboratories. The subject of the discussion, "The Reactivity of Free Radicals", was deliberately chosen to focus attention on the more quantitative aspects of the chemistry of free radicals. The Faraday Society has already held a number of discussions directly concerned with radicals and having a considerable bearing on such specialized subjects as oxidation, polymerization and related phenomena. In 1947 the discussion on labile molecules marked the opening of the quantitative phase. Here the principles of determining the absolute reactivity of radicals became apparent, and the complete chemistry, as well as the kinetics of reactions, began to develop. In five years extremely rapid progress has been made, and the present discussion covered the whole field, with the exception of the chemistry of polymer radicals, so that it was possible to appreciate from the papers the present position of what used to be a rather nebulous and highly controversial part of physical chemistry. The character of the discussion naturally took special notice of the important developments in Canada in this field; in fact, it was particularly appropriate that the discussion might in this way pay a tribute to the progress of Canadian physical chemistry. The Canadian interest centred mainly on gas phase reactions, while the British contributions were more concerned with liquid phase phenomena. Some measure of Canadian achievement may be found from the fact that half the papers originated from the western side of the Atlantic.

Perhaps the more striking feature of the papers presented to the meeting is the variety of methods that can be brought to bear on the problem of radical reactivity. The conventional kinetic approach, namely, the effect of measurable variables like concentration, temperature and intensity of light on the rate of reaction, has been supplemented by quite independent methods, so that the rather tentative conclusions about mechanism devised from kinetics may be much more firmly established and the reality of the existence of radicals proved beyond all doubt.

One of the most striking new methods is flash photolysis (R. G. W. Norrish and G. Porter). Here an intense flash of radiation of short duration is projected into a reaction system, and, if radicals are formed, their concentration is so remarkably high that their ultra-violet absorption spectra may be recorded, with the great advantage of certain identification. Furthermore, the variation of concentration with time may be followed by suitable modification of the apparatus so that velocity coefficients can be determined in the most direct manner possible. For example (G. Herzberg and D. A. Ramsay), it has been known for some time that ammonia undergoes primary photolysis to hydrogen atoms and, it is suspected, amine radicals. Now, with flash photolysis, the existence of the amine radical shows up in its absorption spectrum. Further confirmatory evidence comes from observations on ammonia labelled with nitrogen-14. With the identification of the spectrum of NH_2, the so-called α-bands of ammonia which appear in discharges through ammonia, in ammonia flames and even in comets, can now be ascribed to a well-defined amine-emitter. The flash photolysis method is particularly useful in the study of explosions, for a photochemically active flash is so short in duration that the heating of the system occurs adiabatically and may easily reach and exceed the ignition temperature of an explosive mixture. Thus a new and controllable means of initiating explosions becomes available; but far more important is the fact that the nature of some of the radicals and the variation of their concentration with time may be followed throughout the short period of reaction. For example, with acetylene–oxygen mixtures sensitized by nitrogen dioxide, OH, CN, C_2 and CH radicals can all be observed simultaneously, and controversy as to the nature of these active intermediates at once stilled. Another application of the method makes it practicable to study photochemical reactions that do not ordinarily take place. If chlorine and oxygen are illuminated nothing happens, but by flash irradiation the hypochlorite radical can be observed and its reactions readily followed (G. Porter and F. J. Wright).

Another equally valuable but difficult technique consists in introducing a representative sample of a reacting mixture into the ionization chamber of a mass spectrometer and detecting any radicals present, owing to the fact that the ionization potentials are smaller than those of the molecules from which they were derived. The appearance potential, mass number, and the magnitude of the positive-ion current in sufficiently simple systems serves to identify the radicals. The first experiments with this method were essentially qualitative in nature, but now quantitative information about the efficiency of radical production is becoming available (F. P. Lossing, K. U. Ingold and A. W. Tickner). For example, in the primary decomposition of ethylene oxide each molecule gives rise to 0·6 methyl radicals, and with propylene the figure is down to 0·36. This promises well for the elucidation of the primary step in thermal transformations and therefore supplements the evidence from purely kinetic sources.

Although new methods yield new information about radical reactivities, there is much to be done by the older methods, provided sufficiently simple systems are investigated. For example, in the attack by methyl radicals on hydrogen molecules, experiments with all the deuterated varieties of the entities concerned show that the nature of the molecule rather than that of the radical determines reactivity (T. G. Majury and E. W. R. Steacie). Again, the production of atomic hydrogen by means of a hot tungsten filament in a flow system has resulted in a much clearer picture of the mechanism of attack on the ethane molecule. There seems to be little doubt that dehydrogenation is the first step, followed by the interaction of atomic hydrogen with the ethyl radical to yield two methyl radicals, the reaction being completed by the hydrogenation of the methyl radicals (M. R. Berlie and D. J. Le Roy). Another

convenient way of generating atomic hydrogen consists in the photodecomposition of hydrogen sulphide thus:

$$h\nu + H_2S = H + SH.$$

The hydrogen atoms either decompose another molecule of hydrogen sulphide or interact with an olefine added to the system. By this competitive method the relative reactivities may be obtained. With paraffins the hydrogen atoms merely abstract hydrogen atoms, but by using deuterium sulphide the ratio HD/D_2 that is found gives a measure of the competition of the process involved (B. de B. Darwent and R. Roberts).

In the photolysis of complex polyatomic molecules like biacetyl, there is plenty of evidence of initial fission into acetyl radicals. Complications immediately arise when such radicals not only undergo further decomposition but, in addition, attack biacetyl. Precise quantum-yield measurements coupled with complete analysis of the reaction products can go a long way to obtaining the sequence of radical reactions involved. Such an analysis is normally extremely tedious, but by mass spectrometry the quantum yields for the production of all the molecules are readily measured so that a much more reliable scheme may be constructed (F. E. Blacet and W. Bell). When radicals from ketones (for example, diethyl ketone) are liberated in the presence of oxygen, the character of the reaction changes completely because of the rapidity with which oxygen adds on to the ethyl radical. Even at room temperature short chains are propagated in such a mixture. Instead of the radical yielding carbon monoxide, the final product of attack is carbon dioxide (A. Finkelstein and W. A. Noyes, jun.). Sometimes it is possible to choose a molecule for photochemical studies in such a way that only one of the radicals produced is sufficiently reactive to require study. Trifluoromethyl iodide is a case in point. The iodine atom can be photolysed off in the gas phase, leaving the trifluoromethyl (CF_3) radical for study. Measurement of quantum yield gives the surprisingly low value of 0·02–0·13, which apparently is mainly due to a fast back-reaction between the two entities concerned which can be suppressed to some extent if the trifluoromethyl radical reacts with an added molecule sufficiently rapidly (J. R. Dacey).

The nature of active nitrogen has been the cause of violent debate for forty years. In this discussion it has been admitted as a free radical mainly on the basis that it will attack olefines and hydrocarbons—the olefines faster than the paraffins, hydrocyanic acid being the main product. This leads to the strong suspicion that atomic nitrogen is the source of the activity, and this is supported by the fact that absorption lines in the vacuum ultra-violet spectrum due to atomic nitrogen can be identified (C. A. Winkler and H. I. Schiff). The long-continued glow is, however, difficult to understand on this assumption, since the atoms ought to disappear quite quickly even in pure nitrogen. Another kind of discharge, in water vapour in a flow system, can give rise to production of up to 50 per cent hydrogen peroxide in a liquid-air trap, thus demonstrating that hydroxyl radicals combine at low temperatures. When the contents of such a trap are warmed, first hydrogen and then oxygen is evolved, and water and hydrogen peroxide remain. How these gases are held in the cooled material is a matter not yet satisfactorily settled (P. A. Giguère, E. A. Secco and R. S. Eaton).

Nitric oxide has long been used as a retarder of gas-phase radical reactions in order to estimate chain-lengths. Under suitable conditions nitric oxide is a supporter of the combustion, in flames, of hydrogen, ammonia and hydrocarbons (G. K. Adams, W. G. Parker and H. G. Wolfhard). Although the results are preliminary, these studies open up another unexplored field of radical chemistry. Another inhibitor of chain reactions—lead tetraethyl—is now supposed to act through the medium of lead oxide (G. H. N. Chamberlain, D. E. Hoare and A. D. Walsh).

The discussion on processes in the liquid phase revealed a similar broad approach to the reactivity of radicals. There is as yet very little evidence about the behaviour of the same radical in both the liquid and gas phases, and thus a direct connecting link is missing. At present, the kinetics of liquid-phase radical reactions are treated as if they were gas-phase reactions in regard to the dynamics of collisions. On the whole, the analogy with gases works well enough, but occasionally difficulties appear which demonstrate that the analogy breaks down. Much of the information about liquid-phase radical chemistry is derived from studies in addition-polymerization, but this topic was excluded to make room for a discussion of other radical reactions. Photosensitizers are extensively used to initiate radical reactions, and the elucidation of mechanisms is important. Therefore, studies on the photo-oxidation of anthracene (E. J. Bowen and Miss K. K. Rohatgi) and of the photochemistry of anthracene dissolved in carbon tetrachloride yield a great deal of information concerning the interaction of electronically excited molecules with reactive substrates. The dehydrogenation of aldehydes is an essential step in the oxidation of these molecules. The resultant radicals do not in general undergo decarbonylation. Similar dehydrogenation may be brought about by the radical $Me_2C(CN)$, but not efficiently. Thiols, however, enormously increase the rate of dehydrogenation and are regenerated in a cyclic process, so much so that the aldehydes are readily decarbonylated to the corresponding hydrocarbons (W. A. Waters and K. E. J. Barrett).

The decomposition of hydroperoxide provides another means of generating radicals. Normally, such a decomposition is a unimolecular process; but this does not always happen, for the reaction in certain circumstances becomes bimolecular, kinetically, though radicals still form a primary product of decomposition (L. Bateman, Mrs. H. Hughes and A. L. Morris). In the presence of certain oxidizable substances hydroperoxides can be induced to decompose very much more rapidly than on their own. This is industrially important, for it enables polymerization to be carried out at lower temperatures. Poly-ethylene polyamines of the general formula $H_2N(C_2H_4NH)_xH$ are particularly effective if they are associated with ferrous iron as a complex (R. J. Orr and H. L. Williams). Many such organic reactions are apparently simple stoichiometrically, but the mechanism is very much more complex. Such an example is the direct addition of trichlorobromomethane to vinyl acetate or cyclohexene. Kinetic methods, however, make it possible to analyse the mechanism completely and to get quantitative data about the reactivity of trichloromethyl radicals and derived radicals such as $CCl_3.CH_2.CH(OCOCH_3)$, which data have important application in many related fields (H. W. Melville, J. C. Robb and R. C. Tutton).

It has been known for many years that heavy metal ions which are present even in small traces can accelerate radical reactions like oxidation. These heavy metal ions, such as cobalt, act as true catalysts by means of electron transfer reactions with hydroperoxides, for example, giving rise to radicals which then initiate reactions. A typical reaction is $M^{2+} + ROOH \rightarrow M^{3+} + RO\cdot + OH^-$. If M is cobalt, then Co^{2+} is so powerful an oxidizing agent that it decomposes water as $Co^{3+} + OH^- \rightarrow Co^{2+} + OH\cdot$. Actual reactions are usually much more complex, but kinetic methods are leading to a complete elucidation in some cases (C. E. H. Bawn). With another related system—ferrous iron and hydrogen peroxide—benzene may be readily oxidized at room temperature with the production of phenol and diphenyl resulting from the dimerization of phenyl radicals produced by the dehydrogenation of benzene with hydroxyl radicals. Again, the precise mechanism yields to kinetic analysis (J. H. Baxendale and J. Magee). Sometimes it is not possible to perform a complete analysis, as, for example, in the attack of a phenyl radical on a variety of substituted benzene derivatives. However, it is possible to get relative rates of attack. In this system there is, fortunately, some guidance from the quantum-mechanical theory of aromatic structures (D. H. Hey and G. H. Williams). This guidance is lacking in the interpretation of most radical reactions. In fact, this lack of theory in radical reactions is a serious barrier to further progress. There is an increasing and exact body of experimental data available, and there is as yet very little in the way of fundamental explanation of even relative reactivities, apart altogether from absolute reactivities.

In many radical reactions large radicals are produced which may break up thermally before the next reaction-step takes place. Decarbonylation, referred to above, is an example, whereas degradation of hydrocarbon radicals and polymer radicals is well known. The methods of dealing with yet another complication were also considered in the discussion (F. S. Dainton and K. J. Ivin). More complicated still are those systems in which heterogeneity exists at first or is produced during the course of a reaction. This can happen in some oxidations and in polymerizations such as styrene and maleic anhydride, and leads to a state of affairs where homogeneous reaction treatment is not adequate to cope with the situation (C. H. Bamford and W. G. Barb).

H. W. Melville

THE HUMAN BLOOD GROUPS

By Dr. F. STRATTON

Director of the Regional Blood Transfusion Centre, Manchester

THE Medical Research Council has issued a revision[1] of its Memorandum No. 19, on "*Rh* Blood Groups and their Clinical Effects". Some of the sections have been considerably revised but others have only minor alterations.

The *Rh* system has been one of considerable interest and stands, as it were, at the crossroads between the older *ABO* and *MN* blood groups and those that have been discovered more recently. With the investigation of the *Rh* system the complexity of the human blood groups was realized, and the significance of their clinical effects more appreciated and understood.

Blood group systems	Year of discovery	Erythrocyte antigens	Principal types	Frequency of principal types (per cent)	Known antibodies
ABO	1900	$A_1A_2\ B$	A_1B	3	anti-A
	1911		$A_1\ A_2$	40	anti-A_1
			B	8·5	anti-B
			O	48·5	
MN	1927	*MN Ss*	*M.S*	20	anti-*M*
S s	1947		*MN.S*	28	anti-*N*
			M.s	8	anti-*S*
			MN.s	22	anti-*s*
			N.S	7	
			N.s	15	
P	1927	*P*	*P*-pos.	77	anti-*P*
			P-neg.	23	
Rh	1940/5	*CcDdEeCw*	*cde/cde*	15	anti-*D*
			cDE/cDE	2	anti-*C*
			CDe/CDe	17	anti-*E*
			cDE/cde	11	anti-*c*
			CDe/cde	32	anti-*e*
			CDe/cDE	12	anti-*Cw*
			cDe/cde	2	
Lutheran	1945	*Lua*	*Lu(a+)*	8	anti-*Lua*
			Lu(a−)	92	
Kell	1946	*K k*	*KK*	0·2	anti-*K*
			Kk	10	anti-*k*
			kk	90	
Lewis	1946	*Lea Leb*	*Le(a+b−)*	22	anti-*Lea*
			Le(a−b+)	70	anti-*Leb*
			Le(a−b−)	8	
Duffy	1950	*Fya Fyb*	*FyaFya*	66	anti-*Fya*
			FyaFyb	34	anti-*Fyb*
			FybFyb	77	anti-*Fyb*
Kidd	1951	*Jka*	*Jk(a+)*	23	anti-*Jka*
			Jk(a−)		

The accompanying table shows the commoner human blood groups, with English frequencies[2]. The *ABO* frequencies are Manchester ones. Including the *Rh* system, six of the series have been discovered during the past ten years.

Blood groups are due to the presence of antigens on the surface of the red blood cells. These erythrocyte antigens when injected into man or animals produce, sometimes in one, sometimes in both, a specific antibody. This antibody is used for the detection of the blood group, and, therefore, the determination of a new blood group antigen depends upon the finding of a particular antibody and the establishment of the fact that it determines a new antigen present on the surface of the red cell.

The blood groups listed in the table are the commoner ones, but others have been found which have been aptly labelled by Levine[3] as 'private' blood groups, that is, the positive or negative reactions are found only within a particular family, such as the *Miltenberger* group which he described and the *Levay* group of Callender and Race[4]. Another antigen is the *Tja* antigen of Levine[3], which is so far known to be absent only from the red blood cells of persons whose sera contain the antibody, or from their immediate relatives.

The antibodies which are used for the typing of blood groups are either human or animal in origin. The human antibodies may be regularly occurring ones, such as anti-*A* and anti-*B* antibodies, with which Landsteiner[5] first discovered the *ABO* groups at the beginning of this century. These are the only regularly occurring blood group antibodies in human blood. Other blood group antibodies do occur naturally in human serum, that is, not as a result of immunization; but their occurrence is irregular and their presence atypical. Such antibodies are the anti-*P* which detects the *P* blood group, and the *Lewis* series of antibodies which detect the antigens

of the complicated *Lewis* blood group system. Immune human antibodies have lately been used for the discovery of the more recent blood groups; for example, the *S* sub-groups of the *MN* system and the *Kell*, *Duffy* and *Kidd* groups. These immune antibodies have resulted either from repeated immunization due to blood transfusion, or to the iso-immunization which occurs sometimes during pregnancy, or to a combination of both these factors.

Animal antibodies have been used for a long time for *MN* typing, and the *Rh* system itself was first discovered by Landsteiner and Wiener[5] using animal anti-*Rh* serum. Nowadays, however, with the exception of the *MN* groups, most blood grouping is done using natural or immune human antisera.

The great increase in the discovery of human blood groups in the past few years has been due partly to the occurrence of greater chances of immunization (in the main caused by the increase in blood transfusion therapy) as well as to the realization that pregnancy may cause iso-immunization, and partially to technical advances. Had no technical advances been made, it is quite possible that many of the newer blood groups would not have been discovered, since, in spite of the presence of the antibodies, these would have remained undetected. This may well mean that there are other blood group antigens present on human erythrocytes which may be detectable when suitable technical methods are available. It is probable, too, that more attention will be given to the study of the antibodies themselves, since it is the ability to recognize the antigen – antibody reaction on which substantially depends the recognition of new blood groups. Many different antibodies do not necessarily mean many different heritable agglutinogens.

Another interesting study has been that of the frequency of the various blood groups in the different races of man. It was known previously that the *ABO* and *MN* groups occurred in the different races of man with slightly different frequencies, but when the newer blood groups were examined it was found that these were widely different. Negroes probably have greater differences from the White than many other races; for example, in the *Rh* system one type (*cDe*/*cde*, Rh_0r) has a frequency of about 2 per cent in the English population but about 46 per cent in the Negro population[7]. Again, in the Chinese[7], *Rh*-negative persons are almost unknown, whereas in England they number about 17 per cent of the population; similarly, in studies of South American Indians[8], the *Duffy* blood group is always found to be negative, whereas in White populations 65 per cent are *Duffy*-positive. In North-West Pakistan, 91 per cent of the population are *Duffy*-positive[9].

These are very remarkable differences, but other interesting things have been discovered. It has always been realized that the *Rh* system was one of great intricacy; but for some time it had been thought that the *ABO* and *MN* groups were, compared with this, relatively simple ones. Study of these groups in the different races of man, however, has revealed that they are more complex. In the *MN* groups the *S* sub-groups were found in 1947; Landsteiner, Strutton and Chase[10] originally described a different type of *M* in Negroes, and Ikin and Mourant[11] have described another variety of *M* which is probably different from the former. In the *ABO* groups it has been found that certain group *O* Indians have, in their sera, an antibody which had always previously been considered to be of an anti-*O* variety[12]. This obviously does not fit our present ideas, and reveals further blood group characters within the *ABO* groups. Thus we see that whereas previously the complexity of the human blood groups was realized from serological and genetical studies, latterly their complexity has been further revealed by studies of the blood groups in the different races of man.

Soon after the discovery of the human blood groups, it was found that they were inherited and that the erythrocyte antigens were determined by allelomorphic genes. The inheritance was according to the Mendelian laws. Blood typing is generally possible; but genotyping may be possible only in certain cases. Genotyping is desirable since it is more accurate, and it is often necessary to know whether a person is homozygous or heterozygous with respect to a particular agglutinogen. If this is to be known, it is not only necessary to have the antibody of the particular blood group agglutinogen but also the antibody of its allele or, if the system is complex, the numerous antibodies of the system. Blood typing is sometimes actual genotyping—for example, in the *MN* system—in contradiction to the *ABO* groups where typing is not genotyping. In some of the more recently discovered groups, such as the *Kell* and *Duffy* systems, it was at first possible to group a person as *Kell*-positive or *Kell*-negative, or *Duffy*-positive or *Duffy*-negative; but later, other antibodies have been discovered to their alleles, the one in the *Kell* system being referred to as an 'anti-*k*' antibody, and that in the *Duffy* system as an 'anti-*Fy*^{b}' antibody, and consequently in these systems nowadays it is possible to genotype people. Similarly, in the *Rh* system, a large amount of genotyping can now be done.

Most blood groups are inherited independently of one another; but more recently it has been suggested that the *Lewis* group is linked with the *Lutheran* group[13].

Intensive studies have been carried out to try to associate blood groups with diseases. Iso-immunization of pregnancy is known to occur and may produce hæmolytic disease of the newborn. In these cases, the commonest responsible blood group is the *Rh* one. Linkage between blood groups and human characters has been studied many times, but no definite case of linkage has been established, although Penrose[14] has suggested a possible linkage between bright red hair and the *ABO* groups.

Blood groups are of especial interest in the study of human genetics because they are normal physiological characters, and as such are a feature of the whole population; moreover, from a genetical point of view, they are clear-cut characters, readily charted and scored; they are unaffected by environment. Their manner of inheritance is largely simple, the determinant genes being associated with one pair of chromosomes. They are, therefore, of great value in the study of human genetics, their wide distribution and complete penetrance always making them applicable, unlike other traits. It must be remembered, however, that the presence of the individual is required for such examination and studies; these, therefore, are restricted to three or four generations, and the possibility of illegitimacy must always be borne in mind. Nevertheless, the blood groups form a base-line from which to work, and it is desirable that human genetical studies should always be accompanied by a study of the blood groups, if this is possible.

Twinning is of considerable interest to human geneticists, and blood groups have been especially helpful in such cases. With the number of blood groups now known, if the twins are like-sexed, it is possible to calculate the chances of monozygosity[2]. The present writer has found it particularly useful in the study of a series of twins in which one child suffered from a congenital abnormality which the other did not possess; in a number of these cases the blood groups tended to show that the twins were monozygous.

Blood groups, of course, are of interest to the physician because of their importance in blood transfusion therapy, and they have also been used in cases of disputed parentage and in medico-legal work. In the case of disputed parentage, the *ABO*, *MN* and *Rh* groups are the ones that are used, because in these blood groups large numbers of family studies have been undertaken and their mode of inheritance is clearly defined and beyond doubt.

Landsteiner once said that blood groups would some day become as valuable as finger prints in the recognition of the individual. There is no doubt that recent studies have more and more established the individuality of the blood. There are now 300,000 blood-group combinations; some of these are extremely rare and occur very infrequently in the population. It is probable that more blood groups remain to be discovered; therefore, the study of human blood groups is one that assists in establishing the individuality of man, and the revised Medical Research Council publication is a valuable contribution on the subject.

[1] Medical Research Council. Memorandum No. 27 (Revision of Memorandum No. 19): The Rh Blood Groups and their Clinical Effects. By Dr. P. L. Mollison, Dr. A. E. Mourant and Dr. R. R. Race. Pp. vi+72. (London: H.M. Stationery Office, 1952.) 3s. net.

[2] Race, R. R., and Sanger, R., "Blood Groups in Man" (Blackwell Publications, 1951).

[3] Levine, P., *Trans. N. Y. Acad. Sci.*, **13**, 6 (1951).

[4] Callender, S., and Race, R. R., *Ann. Eugen.*, **13** (2), 102 (1946).

[5] Landsteiner, K., *Zbe. Bkt.*, **27**, 357 (1900).

[6] Landsteiner, K., and Wiener, A. S., *Proc. Soc. Exp. Biol. Med.*, **43**, 223 (1940).

[7] Miller, E. B., Rosenfield, R. E., and Vogel, P., *Amer. J. Phys. Anthrop.*, **9** (2), 115 (1951).

[8] Pantin, A. M., and Junqueira, P. C., *Nature*, **167**, 998 (1951).

[9] Cutbush, M., Mollison, P. L., and Parkin, D. M., *Nature*, **165**, 188 (1950).

[10] Landsteiner, K., Strutton, W. R., and Chase, M. W., *J. Immun.*, **27**, 469 (1934).

[11] Ikin, E. W., and Mourant, A. E., *Brit. Med. J.*, i. 456 (1951), and personal communication.

[12] Bhende, Y. M., Deshpande, C. K., Bhatia, H. M., Sanger, R., Race, R. R., Morgan, W. T. J., and Watkins, W. M., *Lancet* (i), 903 (1952).

[13] Mohr, J., *Acta Path. et Microb. Scand.*, **29** (3), 339 (1951).

[14] Penrose, L. S., *Ann. Eugen.*, **6**, 133 (1935).

ENERGETICS OF SENSORY EFFECTS

AT the recent meeting of the British Association in Belfast, Section I (Physiology) arranged a session entitled "Energy into Nerve Impulses". The first paper was by Prof. E. D. Adrian, president of the Royal Society, who spoke on the sense of smell. He said there is much evidence that the olfactory organ in man is far less sensitive than the larger organs in dogs or sharks and the much smaller organs in moths and insects. It is likely that this difference in sensitivity is due more to a greater power of discriminating scents than to a lower absolute threshold at the end organs. Prof. Adrian then turned to the results he has obtained by recording, with a fine electrode in the olfactory bulb, the nervous discharges which occur in the mitral cells of the rabbit, while the nose is subjected to a known concentration of a suitable substance. With most smells excitation is confined to each inspiration, and it is also found that the concentration which is just perceptible to the human nose differs very little from that just capable of producing an olfactory discharge in the rabbit. Nervous discharges recorded in this way show a number of features by which the discharge may be distinguished as due to a particular smell. The differences in the olfactory discharge are of two kinds, depending on differences in the excitability of the different receptors and of different regions of the organ to different materials; and on differences in the time course of the discharge, the latency, duration and rate of rise and fall in the frequency of the impulses.

Prof. Adrian first considered the different sensitivities of individual units. It is possible to distinguish one unit from its neighbours by careful placing of the electrode, and it is nearly always possible to find a substance which will excite this single unit at a concentration too low to excite the others. Thus, in one preparation the single unit responded to acetone in a concentration at which no other unit did, and to a concentration of amyl acetate which excited other units, while it was unaffected by pentane in a concentration that excited the others. The substances tested could be classed in two groups—water soluble and lipoid soluble. Units responding to one group rarely responded to the other, and there is also a regional distribution, the anterior parts of the organ responding mainly to the water-soluble group and the posterior part to the lipoid-soluble group. The latency of the response to the water-soluble group is always less than 0·025 sec., while with substances insoluble in water it is longer than 0·05 sec. The substances which excite after a short latency produce a short discharge, and vice versa. Prof. Adrian concluded by saying that some of these differences may depend on the gross structure of the organ, and he suggested that the specific sensitivities of the receptors might be related to the length of the terminal part of the cell, which varies. He thought it unlikely that olfactory discrimination depends on a limited number of distinct receptor types.

Dr. Hallowell Davis, director of research of the Central Institute for the Deaf, St. Louis, Mo., then discussed the problem of how mechanical energy is converted into nerve impulses in the inner ear. The sensitivity of the cochlea is so great that the movement of the basilar membrane at threshold is probably less than the diameter of a hydrogen atom, and the amount of energy is of the same order of magnitude as the energy of thermal agitation of the molecules. If the cochlea were a transducer, this energy would have to be converted extremely efficiently, and the nervous tissue involved would need to be on the verge of spontaneous discharge. Dr. Davis described the results of recent experiments and put forward a new hypothesis that explains the action of the cochlea as an electronic valve mechanism rather than a transducer. The cochlea microphonic has been suggested as the immediate stimulus to the terminals of the auditory nerve, but at one time it seemed difficult to reconcile this hypothesis with the long latency that had been observed between the peaks of the microphonic and the impulses. This difficulty no longer exists, however, because the summating potential which Davis and his collaborators previously believed to be a local potential in

the receptor cells has now been shown by Davis and Tasaki to be an action potential in the nerve fibre in the neighbourhood of the hair cells. This shows that the latency in the initiation of the impulses is very short, and Dr. Davis stated that he now accepts the hypothesis that the cochlea microphonic is the immediate stimulus to the auditory nerve fibre.

There has been indirect evidence that the cochlea microphonic is associated with the hair cells of the organ of Corti, and very recent explorations of the cochlea, independently by Békésy at Harvard and by Tasaki at the Central Institute for the Deaf, have strongly supported this conclusion. The source (or sink) for the cochlea microphonics seems to be the hair-bearing end of the hair cells. This is where the hairs are embedded in the tectorial membrane, and Békésy has shown that it is radial movements of the tectorial membrane across the organ of Corti that are most effective in producing the cochlea microphonics. He has also shown that, if the tectorial membrane is displaced and held in its new position, the microphonic continues as a D.C. potential without further addition of mechanical energy. This provides direct evidence that the mechanism must be of an electronic valve and not of a transducer type. Békésy has found that the endolymph in the scala media is about 80 mV. positive to that in the other scalæ, and that the electrical resistance of the walls of the scala media is high. Dr. Davis put forward the hypothesis that the cochlea microphonic is due to changes in the current flowing from the scala media to the scala tympani, due to changes in the electrical resistance of the hair cells in the region of the hairs, and that this change of resistance is due to, and directly related to, the position of the hairs. He suggested that the source of energy that maintains the potential in the scala media may be in the stria vascularis.

The next paper was on "Light-Quanta into Nerve Impulses", and was given by Dr. M. H. Pirenne, of the Physiology Department, University of Aberdeen. Light falling into the eye causes nervous excitation in the retina and optic nerve, and it is generally accepted that a photochemical change in the retinal receptors is the first step in this process. The retinal receptors, the rods and cones, contain substances (such as visual purple in the rods) which absorb part of the incident light and undergo physicochemical changes in consequence. It is these changes that lead to nerve excitation. Light can only be absorbed in quanta, and fractions of quanta cannot be absorbed (the energy of a quantum is about 4×10^{-12} erg for $\lambda = 0{\cdot}51\,\mu$). Experimental measurement indicates that under the best conditions a rod can become excited when it has absorbed one quantum only. The light sensitivity of the rod, therefore, reaches the absolute physical limit. To enable a human subject to see a dim flash of light, however, a few neighbouring rods must be excited within a short time-interval. Thus, while a rod reacts to one quantum, the organism as a whole requires more than one quantum to give a visual response. One quantum is absorbed by one molecule and reacts with that molecule alone. There must therefore be some mechanism which can amplify such a one-molecule disturbance into a stimulus adequate to set up an impulse.

Dr. Pirenne then turned to the visibility of large, continuously exposed fields, a problem in which he has been interested recently. The threshold for such a field is of the order of 10^{-6} candle/sq. m. At threshold the retina receives extremely little light energy—on the average one quantum is absorbed every 0·1 sec. per 100,000 rods. One-tenth of a second is roughly the time during which the retina can summate the action of light. Physical fluctuations give some parts of the retina more, and others less, than this average, so there may be a group or groups of rods in the retina that are excited within the summation time. These figures show that, in order to make every rod absorb about ten quanta every tenth of a second, we must use intensities equal to about a million times the threshold intensity for a large field. If the central cones are as sensitive as rods, then the same will apply in the fovea, but, if the cones are less sensitive, then even more light will be required. Thus, a single cone cannot be activated with intensities below 0·1 or 0·01 candle/sq. m., simply because at such intensities they generally absorb no light at all. Thus, quantum phenomena probably play as important a part in cone as in rod vision. It can be shown, for example, that in the range from threshold to about 10^1 threshold intensity, the finest details just visible at each intensity are almost as fine as they could be. Visual acuity and retinal sensitivity in this range are linked together, almost reaching the limit set by the quantum properties of light.

In the last paper, on the "Initiation of Impulses at some Sensory Endings", Dr. J. A. B. Gray, of the National Institute for Medical Research, confined himself to considering mechanically stimulated receptors. Certain conditions must be fulfilled before an impulse is initiated at a sensory receptor. A certain minimum amount of energy must be provided; but, as most of this energy is absorbed by inexcitable structures, it is easier to talk in terms of compression or extension of the receptor. A Pacinian corpuscle which can be freed from its surrounding tissues can be excited by compression movements of less than 0·5 μ. With some receptors, including the Pacinian corpuscle, the stimulating movement must also have a minimum velocity, and in this receptor a threshold movement must be complete in about 1 msec.—that is, a velocity of about 0·5 mm./sec.

A minimum velocity is not a necessary condition of excitation for all receptors; Landgren has shown that some receptors in artery walls respond however slowly the pressure rises to its final value. Impulses can sometimes be excited as frequently as a thousand a second from Pacinian corpuscles. A stimulus which satisfies these minimal conditions excites an impulse after a short interval. In the Pacinian corpuscle this interval is about 1·5 msec. when the stimulus only just reaches threshold, but it is reduced to about 0·5 msec. if the stimulus is large. During this interval, the excitability of the ending is steadily increasing, a fact which is shown by giving a Pacinian corpuscle a mechanical stimulus too small to excite and testing its excitability with a short electrical pulse at intervals after the mechanical stimulus. The excitability increases up to the time at which a threshold mechanical stimulus would have initiated an impulse, and then declines. These excitability changes are probably caused by a local potential change that has been observed by Alvarez-Buylla and Ramirez de Arellano. This potential change, unlike the impulse, is confined to the ending, and its size is directly related to the size of the stimulus. Local potentials were first seen in sense endings by Katz, who recorded them from a stretch receptor from a muscle. The potentials from this receptor showed two components: an early peak the amplitude of which was related to the velocity of the stimulus, and a part which was related to the amplitude of the stretch and remained

as long as the stretch was applied. This local potential is probably the immediate cause of the impulse. The mechanism by which the mechanical stimulus produces the local potential is not known, but it seems likely that the mechanical stimulus allows the electrical energy stored in the nerve cell to be released. Stretching a single node of Ranvier does not produce changes comparable to stimulating a sensory receptor. However, a suggestion that there may be specialization of the membrane of sensory terminals comes from evidence that acetylcholine may stimulate sense endings, though this substance seems to play no part in their normal function.

In the discussion that followed, Prof. Adrian was asked whether the adaptation to a smell that is commonly experienced is due to fatigue of the receptor. He replied that an impulse discharge can be recorded for long periods and that the adaptation is presumably central. Dr. Detlev W. Bronk referred to the importance of the chemical environment of nerves and the oscillatory phenomena seen with lack of calcium. Under these conditions impulses occur at intervals which are multiples of a fundamental interval; he said that Dr. Scott had observed similar rhythmical discharges from Pacinian corpuscles. Prof. W. Burns asked Dr. Davis whether the threshold of the auditory receptors could be altered by polarizing currents, to which the latter replied that they can be either raised or lowered according to the polarity of the current. J. A. B. GRAY

OBITUARIES

Dr. W. E. Gye, F.R.S.

W. E. GYE, internationally known as an exponent of the virus hypothesis of cancer, died in Perth, Western Australia, on October 13.

W. E. Bullock, who later changed his name to Gye, was born in the Derbyshire village of Beaston on August 11, 1884. The son of a railway signalman, he tried a number of occupations before becoming a 'pupil teacher'. Later, he obtained a scholarship tenable at University College, Nottingham, and gained the London B.Sc. in chemistry. After spending a year teaching in Birmingham, he began the study of medicine with the financial aid of a friend. During his student days Gye lived simply, found gainful employment during the vacations and repaid the assistance which he had insisted on regarding as a loan. He graduated in Edinburgh in 1913 (Gold Medal) and joined the staff of the Imperial Cancer Research Fund under Bashford and Murray. He served in the R.A.M.C. in charge of a field ambulance in France and Italy during the First World War, and on his return carried out investigations on anaerobic infections with W. Cramer.

Gye and Cramer studied the influences of chemical substances, calcium salts and silica, for example, in producing 'defence rupture' in wounds infected with spores of anaerobic bacteria. Shortly afterwards, Gye collaborated with E. H. Kettle in an investigation of silicosis and miner's phthisis. He then joined the staff of the National Institute for Medical Research with the intention of participating in the experimental studies of dog distemper which were then being planned. Before this work could proceed, a stock of virus-free dogs had to be bred and Gye, in order to obtain some virus experience, commenced work with the Rous sarcoma.

This work on fowl tumours was continued by Gye, and in 1925 he published a paper on the "Ætiology of Malignant New Growths" which attracted widespread attention. He attributed the specificity of various growths, not to a corresponding multiplicity of viruses but to 'specific factors' derived from the host. This thesis was further elaborated and presented together with many experimental observations on fowl tumours in a book with W. J. Purdy, "The Cause of Cancer", published in 1931.

Gye succeeded Murray as director of the Imperial Cancer Research Fund in 1936. The virus hypothesis continued to be one of his main interests, and the problem of obtaining direct and convincing experimental evidence of a causal virus in transplantable mammalian tumours occupied much of his attention. Because of his own negative results with tumour desiccates over a long period, it is perhaps not surprising that in 1949 he interpreted the successful transmission of such tumours in the Fund's laboratory by means of freeze-dried material as evidence of the existence of such a virus.

A gift of lucid exposition was one of Gye's characteristics. He undoubtedly rendered a great service to oncology by undertaking the study of the fowl tumours described by Rous before the First World War. These had been largely ignored because they could be induced *de novo* by virus obtained from them, and therefore could not be reconciled with other ideas on the genesis of cancer in general. Gye's attempts to extend the hypothesis of virus as a continuing cause to all kinds of cancer were highly ingenious, and it is largely due to him that this alternative to other concepts holds the position it does to-day. He believed fervently in his ideas, and in this controversial subject evoked reactions ranging from great admiration to pungent criticism.

Gye was a man of much personal charm. His post-war years were burdened by an increasing disability due to a heart condition, and on retirement from the directorship of the Imperial Cancer Research Fund in 1949 he went to Perth, Australia. He was elected a Fellow of the Royal Society in 1938 and in 1947 was appointed professor of experimental pathology in the Royal College of Surgeons. Gye was twice married, in 1913 to Miss Elsa Gye, who died in 1943 and by whom he had three sons; and in 1945 to Miss Ida Mann, professor of ophthalmology at Oxford. Miss Mann later retired and assisted Gye in his experimental work in London and in Australia.

J. CRAIGIE

Miss K. C. Boswell

MISS KATHARINE CUMMING BOSWELL, born in October 1889, died on September 19, of heat stroke, at Beni Abbes, deep in the Sahara. During her adult life she had a very close connexion with the (then) University College, Southampton. She was a student before and after the First World War; in 1926 she became a lecturer in the Department of Geography; she resigned her lectureship in 1944, and went as co-principal to the Friends' College, Jamaica, in 1945; she returned in 1949 and resumed close relations with the College and Department at Southampton.

Miss Boswell's main interest was in geomorphology, her studies in which were supported by her thorough learning in geography and by her early studies in geology and biology. Her constant aim was to understand, and to help others to do the same. Her students

developed a lasting interest in their work and confidence that they could and should continue such studies long after they had left the University.

From the same desire to understand sprang her long and arduous struggle with the difficult "Morphologische Analyse" of Walther Penck. Controversy raged around his work. She determined that easy access to what he said was necessary. The last weeks, before she went to Algiers for the 19th International Congress of Geology, were spent in reading the proofs of her translation of Penck.

"Land forms under humid and under semi-arid conditions are well known, by personal experience, to the majority of geomorphologists. But I, for one, have never seen the real desert." She tried while visiting South Africa to see Namib but only penetrated the Kalahari. She died in the Sahara, victim of her desire to understand.

Miss Boswell was too modest ever to think that she might have any original contribution to make to geomorphology. Her friends knew otherwise. But understanding was all that K. C. B. asked, and died in pursuit of it.

F. C. Miller

NEWS and VIEWS

Royal Society : Awards of Medals

The following awards of medals have been made by the President and the Council of the Royal Society : *Copley Medal* to Prof. P. A. M. Dirac, for his remarkable contributions to relativistic dynamics of a particle in quantum mechanics ; *Rumford Medal* to Prof. F. Zernike for his outstanding work in the development of phase-contrast microscopy ; *Davy Medal* to Prof. Alexander Robertson for his researches into the chemistry of natural products, particularly the wide range of glycosides, bitter principles and colouring matters containing heterocyclic oxygen atoms ; *Darwin Medal* to Prof. J. B. S. Haldane for his initiation of the modern phase of study of the evolution of living populations ; *Buchanan Medal* to Sir Rickard Christophers, for his outstanding research on malaria and on the *Anopheles* mosquitoes which transmit that disease ; *Sylvester Medal* to Prof. A. S. Besicovitch, for his outstanding work on almost-periodic functions, the theory of measure and integration and many other topics of theory of functions ; *Hughes Medal* to Prof. P. I. Dee, for his distinguished studies on the disintegration of atomic nuclei, particularly those using the Wilson cloud-chamber technique.

Nobel Prize for Chemistry for 1952 : Dr. A. J. P. Martin, F.R.S., and Dr. R. L. M. Synge, F.R.S.

The Nobel Prize for Chemistry for 1952 has been awarded jointly to Dr. Archer John Porter Martin, head of the Physical Chemistry Division of the National Institute for Medical Research, Mill Hill, London, and Dr. Richard Laurence Millington Synge, biochemist at the Rowett Research Institute, Bucksburn, Aberdeenshire. Dr. Martin, after taking Part II of the Natural Sciences Tripos in biochemistry in Cambridge, worked at the Nutrition Laboratory there during 1934–38, mainly on vitamin E and nicotinic acid. Dr. Synge, who had also been trained at the School of Biochemistry, Cambridge, soon became interested, after a short spell in carbohydrate chemistry, in the analysis of proteins. The empirical methods then available for separating the complex mixtures of amino-acids present in protein hydrolysates were unsatisfactory in many respects, and Synge therefore investigated the possibility of separating the N-acetyl derivatives of amino-acids by partition between water and other solvents. In this early work, which was published in 1939, conventional extraction procedures were used. Realizing the relative inefficiency of these methods, Martin and Synge, who had now joined forces, designed and put into operation an all-glass apparatus based on counter-current principles. In 1938, both Martin and Synge accepted appointments at the Wool Industries Research Association laboratory in Leeds, and there ensued a close collaboration in which the respective capacities of these workers complemented one another in an ideal manner. It was realized that bulk extraction procedures were inferior to chromatographic techniques, and Martin and Synge conceived the idea that a combination of the principle of solvent partition and a chromatographic arrangement might be the solution to their problem. They soon found that a system consisting of water-saturated silica as stationary phase and a suitable organic solvent as mobile phase was satisfactory for their purpose. However, the acetylation step was somewhat cumbersome, and attempts were made to separate the amino-acids themselves. It was soon shown that cellulose was suitable as supporting material, and a logical extension of these findings led in 1944 to the development of the now generally familiar paper chromatography. A further and most important extension of these ideas led Martin (now at Mill Hill) to the development of liquid-gas partition chromatography.

Liquid–liquid chromatography, and especially paper chromatography, which were developed originally for the analysis of amino-acids, are now being used in almost every field of organic and inorganic chemistry and biochemistry. The application of these methods especially to the structure and metabolism of natural compounds has made possible advances in our knowledge which would have been considered impossible ten years ago. There has been during the past decade a widespread interest in the general problem of separation of small amounts of closely related substances, in no small measure due to the work of Martin and Synge. The development of synthetic ion-exchange resins, the various modifications of adsorption chromatography and the elaboration of bulk counter-current extraction methods have greatly increased our range of techniques. But the methods evolved by Martin and Synge are probably unique by virtue of simplicity and elegance of conception and execution, and also by the wide scope of their application. This field is still expanding, and it is likely that the invention of liquid–liquid chromatography will be considered by future generations as one of the more important milestones in the development of chemical sciences.

Dr. W. G. Penney, F.R.S.

The recent announcement, recorded in *Nature* of November 1, that Dr. W. G. Penney has been promoted to be knight commander of the Civil Division

of the Order of the British Empire will be particularly welcomed by all associated with the Imperial College of Science and Technology. It was to this College of the University of London that Dr. Penney went in 1927, entering as a Royal Scholar. After gaining a first-class honours degree in mathematics he remained at the Imperial College for two more years, devoting his time to research work in mathematical physics. One result of this work was a paper written in collaboration with Dr. R. de L. Kronig which has become well known and is still widely read by students of metal physics. In 1931 he was awarded a Commonwealth Fellowship and continued his research work at the University of Wisconsin. Two years later he returned to Great Britain to study at Cambridge, where he became interested in the theory of molecular structures, a field of research in which he has made notable advances. In 1936 he was appointed reader in mathematics in the Imperial College and served in this capacity until the outbreak of the Second World War. Early in 1940, he undertook part-time research work for the Ministry of Home Security, and since that time has been increasingly concerned with defence research. The very important part which he has played in this field is now well known, and has been recognized, first, by the conferment of the O.B.E. in 1946, and now by the well-deserved honour recently announced.

Economies in the Department of Scientific and Industrial Research

In a written reply in the House of Commons on October 28 to a question from Sir William Wakefield regarding economies in scientific and industrial research (*Hansard*, col. 1735–7; October 28), the Parliamentary Secretary to the Ministry of Works, representing the Lord President of the Council, stated that no major plan or activity of the Department of Scientific and Industrial Research has been eliminated. A reduction of twenty-five posts in its non-industrial staff has brought the Department's establishment to 3,054. Planned recruitment has accordingly been halted, many outstanding vacancies cancelled and the reduced man-power resources re-allocated, reductions in headquarters staff and in the Building Research Establishment providing the further staff essential for the Mechanical Engineering Research and Hydraulics Research Establishments. The original estimates for the Department for 1952–53 have been reduced to £5,390,950 net, an increase of £24,950 over the estimates for the previous year, the total staff being now 4,049 as compared with 4,317 for 1951–52. Non-industrial staff currently authorized for the headquarters was 281 and for building research 420, as compared with 299 and 489, respectively, actually employed on October 1, 1951. In reply to the question whether the proposed cuts had been agreed by the Advisory Council for Scientific and Industrial Research, it was stated that the decision to restrict the available man-power and to reduce the estimates had been communicated to the Advisory Council and that the re-allocations were made with the Council's knowledge.

National Fuel Problems in Great Britain

The debate in the House of Commons on the Ridley report, recently initiated by the Ministry of Fuel and Power, afforded little evidence about a possible Government fuel policy. Reserve was to be expected in the adoption of some of the Ridley Committee's proposals, though the Minister in his rightly cautious remarks about co-ordination gave no suggestion that he has taken the hint given by the Committee and proposes to exercise the powers he already possesses in a way that would make the new body recommended in the report superfluous. Nor is the Minister prepared to recommend the provision of financial incentives to instal improved solid-fuel appliances for domestic heating, either to private consumers or to local authorities, even to the extent of removal of purchase tax. Equally he was unprepared to give industrialists any incentive to instal fuel-saving rather than other capital equipment. While accepting the Committee's view that competition should continue between the fuel and power industries and that, within a proper framework which maintains full freedom of choice for the consumer, the choice could be relied upon to bring about the best use of fuels, he ignored the essential condition laid down—that fuel prices should closely correspond to the relevant costs of supplying the different fuels. Apart from shirking this critical issue of price, neither the Minister nor his Parliamentary Secretary, who replied to the debate, succeeded in making it quite clear what was meant by their acceptance of the recommendation that an independent advisory service on fuel efficiency should be set up, controlled and financed by industry. The Ridley Committee recommended the continuance of the Ministry's own advisory service; but this the Minister proposes to cut down or at least limit to advice on fuel efficiency in government departments. The Parliamentary Secretary's efforts to elucidate this point are likely to have an unsettling effect on the technical advisers at present in the government service rather than to promote economy.

Scientific and Technical Information for Industry

In opening an industrial and commercial information exhibition at the Manchester Central Library on November 3, A. H. S. Hinchcliffe, after referring to his association with Sir John Stopford in forming the Manchester Joint Research Council in 1944, again stressed the importance of securing the effective utilization by British industry of existing knowledge, and the extent to which the Department of Scientific and Industrial Research is concerned with this problem as well as with the acquisition of new knowledge. Mr. C. Nowell, chief librarian of the Manchester Public Libraries, expressed the view that many of the smaller firms in the area are unaware of the existing facilities of the Commercial Library and Information Department, the Technical Library and the Reference Library in Manchester and the services they could render; Sir Raymond Street, in seconding the vote of thanks moved by Mr. Nowell, agreed that the small firm constitutes a major problem in raising the standard of efficiency and productivity in British industry. The exhibition, which has been arranged in association with the Department of Scientific and Industrial Research and the British Cotton Industry Research Association, illustrates not only the services and resources of the Manchester Public Libraries, and more particularly of the Technical Library and the Commercial and Information Department, but also the work of the Department of Scientific and Industrial Research. Although the main emphasis is laid on the work of the Department in disseminating scientific and technical information through its numerous publications and its own information department, some indication is given of the scientific and technical work carried out,

including, for example, a model of the calorimeter building at the Fuel Research Station and photographs illustrating the work of the Shirley Institute. The exhibition is admirably designed to achieve its purpose of demonstrating the value of technical information to industry in general.

Exhibition of Spanish Scientific Books

An exhibition of recent Spanish publications in science, technology and medicine, organized by the Institute of Spain, was opened by Mr. K. B. Potter, president of the Publishers' Association, in the Science Museum Library, on November 6. In welcoming the exhibition Dr. F. Sherwood Taylor, director of the Science Museum, recalled the evidence in Spain of the enormous antiquity of Spanish metallurgy and acclaimed the Spaniard as a great practical chemist and engineer. He looked back to the age of Alfonso the Wise, when Spanish astronomers led the world, to Ramón Lull, who founded a school important in the progress of chemistry, and to the debt owed to Spain for the development of the merino breed of sheep, founders of great flocks in three continents. This exhibition, he added, demonstrated the vigorous life of science in Spain to-day, particularly in the fields of medicine and engineering. His Excellency the Spanish Ambassador, in closing the ceremony, mentioned that the exhibition contains only a sample of the scientific books, particularly original treatises, published in Spain during the past few years—a period in which scientific activity has been intensified with the development of collective efforts in research and teaching as Spain has become increasingly industrialized. He also referred to the wide circulation of both standard textbooks and original works through Spain and Spanish America. In expressing his gratitude to the Science Museum for opening its library to the exhibition, he spoke of the universal interest in science, of the admiration in Spain for the scientific culture of Great Britain and of the world of science which speaks of friendship and a common task. The exhibition will remain open until November 20.

Quantitative Paper Chromatography of Plant Nitrogen

The value of quantitative partition chromatography on paper in the analysis of the alcohol-insoluble nitrogen of plants has been established in recent investigations by J. F. Thompson and F. C. Steward (*J. Exp. Bot.*, 3, No. 8, 170; 1952). The amino-acid composition of egg albumin, zein, edestin and cucumber seed globulin has been determined by a quantitative method which is described, the chromatographic analytical data accounting completely for the amino-acid nitrogen of the protein hydrolysate as determined by the Kjeldahl method. The analyses of the alcohol-soluble and -insoluble fractions of potato tubers of several varieties have now been carried out, attention being directed to differences which have been observed as between both samples and varieties. No correlation has been observed between the relative proportions of free amino-acids in the tubers and in the alcohol-insoluble protein; indeed, certain compounds present in the free state in the tissue do not occur in the protein, while the amides are stated to be considerably in excess of their possible occurrence combined in the protein. Hence the tentative conclusion is reached that the free soluble compounds are not directly combined as such to form proteins.

Petrological Identification of Stone Axes

The third report of the Committee concerned with the petrological identification of stone axes is published in the *Proceedings of the Prehistoric Society* for 1951 (Pt. 2). Polished celts are frequently made from fine-grained igneous rocks, tough materials making carpentry possible. In thin sections these rocks can be identified under a polariscope, and sometimes the material is not one of common occurrence. In such cases the site whence came the rock substance can be located, and indeed a number of such workshop sites are known. This third report continues the investigations and gives much more information on this interesting matter which helps to suggest the lines of ancient trade routes along which were passed the raw materials utilized for the making of ground and polished celts.

Reopening of the Mining Collection at the Science Museum, London

The Mining Collection at the Science Museum, South Kensington, London, S.W.7, will be reopened in much enlarged form by the Right Hon. Geoffrey Lloyd, Minister of Fuel and Power, on November 18. The basic conception in the design of the new Collection, which occupies an area of nine thousand square feet, has been to give the visitor the impression of being underground in the actual workings of a mine; one of the principal exhibits is a full-scale model of a coal face supplied with the latest equipment and machinery. Adjacent to this are various sections illustrating the historical development of the many ancillary services which are essential in mining and which have played such an important part in the safety and social progress of the miner; these sections deal with coal-cutting, metalliferrous mining, breaking ground, mine transport, winding, boring and sinking, mine lighting, mine ventilation, rescue work, hand tools, roof supports and surface mining. The development and building of this Collection has only been made possible by the kindness and generosity of the many manufacturers of mining equipment used in Great Britain, who have provided not only full-sized equipment but also many fine models and finance.

Insignia Award of the City and Guilds of London Institute

The City and Guilds of London Institute has recently established an "Insignia Award" in technology which is designed to be a mark of distinction conferred by the Institute on those who have combined with a sound practical training an adequate knowledge of the fundamental scientific principles of their industry and have shown a capacity for leadership and administration and for applying such wider knowledge to their particular industry. The Award will entitle the holder to use the letters C.G.I.A. after his name. The five main sections at present approved for the Award are the chemical, constructional, electrical, mechanical and textile industries; but these divisions are meant to cover a broad range of particular industries. The preliminary conditions required of a candidate are that he be not less than thirty years of age, have completed the full period of apprenticeship or equivalent training suitable for his industry, have obtained the Full Technological Certificate of the Institute in an appropriate branch of technology, have had at least seven years suitable industrial experience subsequent to his initial apprenticeship

(except in very special circumstances, war service cannot be taken into account), and give the names of three referees. The two main tests for the Award are the writing of a thesis and the subsequent interview by a body of experts. As regards the former, the candidate is not expected to present a record of original research, but rather give a critical appreciation of a problem in industry, backed by relevant reading, with practical suggestions for solving the problem and for future developments; it is suggested that ten to twenty thousand words should be the length of the thesis. The interview, to which much importance will be attached, is designed to gain an appraisal of the candidate's education, training and career, together with any possible points arising from his thesis. All communications regarding the Award should be addressed to the Director, Department of Technology (I.A.), City and Guilds of London Institute, 31 Brechin Place, South Kensington, London, S.W.7.

Mineralogical Society: Officers 1952-53

THE officers of the Mineralogical Society for 1952–53 have been elected as follows: *President*, Dr. J. Phemister; *Vice-Presidents*, Dr. A. F. Hallimond and S. J. Shand; *Treasurer*, Prof. J. H. Taylor; *General Secretary*, Dr. G. F. Claringbull (c/o Geological Society, Burlington House, London, W.1); *Foreign Secretary*, Dr. L. J. Spencer; *Editor of the Journal*, Dr. L. J. Spencer.

University of London: Appointments

THE following appointments have recently been made in the Imperial College of Science and Technology, London: Dr. E. A. R. Braude, to the University readership in organic chemistry; Mr. M. W. Humphrey Davies, to the University readership in electrical engineering.

Christmas Lectures in London for Juveniles

LECTURES for juvenile audiences in London during the forthcoming Christmas holidays have been arranged as follows. At the Royal Institution (21 Albemarle Street, London, W.1) the 123rd course of lectures will be given on December 27 and 30, 1952, and January 1, 3, 6 and 8, 1953, by Dr. F. Sherwood Taylor, director of the Science Museum, his subject being "How Science has Grown"; the fee for these lectures is children (10–17 years) £1, adults £2. At the Royal Photographic Society (16 Princes Gate, London, S.W.7) three lectures on "How We see Colour", "How We Measure Light" and "Putting Colour into a Photograph" will be given on January 1, 2 and 5, 1953, respectively; tickets can be obtained, without charge, from the Secretary of the Society.

Announcements

H.R.H. THE DUKE OF EDINBURGH has been elected president of the Royal Society of Arts. Her Majesty the Queen, who, as Princess Elizabeth has been president since 1947, now becomes patron.

THE Lord President of the Council has appointed Sir Hugh Beaver, managing director of Arthur Guinness, Son and Co., Ltd., to be a member of the Advisory Council for Scientific and Industrial Research. Mr. I. A. R. Stedeford, chairman of Tube Investments, Ltd., has resigned his membership of the Council because of pressure of other duties.

PROF. A. J. KLUYVER, president of the Royal Netherlands Academy, will deliver the Leeuwenhoek Lecture at the Royal Society on November 20 at 4.30 p.m. The subject of the Lecture will be "The Changing Appraisal of the Microbe". Applications for invitations should be sent to the Assistant Secretary, Royal Society, Burlington House, London, W.1.

THE Anglo-Saxon Petroleum Co., Ltd., has informed University College, London, that it intends to give the College £2,700 annually for the provision of scholarships in chemical engineering and of apparatus for the furtherance of the study of chemical engineering in the Ramsay Memorial Laboratory.

THE Humber Laboratory, at Wassand Street, Hull, a new out-station of the Torry Research Station, Aberdeen, will be opened on December 5 by Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, supported by Admiral Sir Robert Burnett, chairman of the White Fish Authority, and Mr. J. Croft Baker, chairman of the British Trawlers' Federation. Dr. C. L. Cutting is in charge of the new Laboratory.

AN appeal has been put forward by Mr. James Paton (*Irish Astro. J.*, 2, No. 2; June 1952) for aurora observers to co-operate in the proposed survey of the frequency of auroræ over the British Isles. The primary purpose of the work is to prepare a map of the area covered by the survey, showing the frequency of aurora nights in each latitude. The success of the scheme requires a large number of observers, and those who are willing to co-operate or who require further information should write to Mr. Paton at the Department of Natural Philosophy, University, Drummond Street, Edinburgh, 8.

THE Institute of Rural Life at Home and Overseas, in co-operation with the Association of Agriculture and the Institute of Education, University of London, is arranging a meeting on "Food Science at Home and Overseas", to be held in two parts, on the mornings of November 22 and 29 respectively, at the Institute of Education, Malet Street, London, W.C.1. The meeting, for which a fee of 1*s.* (including coffee) is charged, is designed primarily for school teachers and students and will consist of four lectures by well-known authorities. Application forms and further information can be obtained from the Secretary, Institute of Rural Life, 84 Eccleston Square, London, S.W.1.

A series of four public lectures has been arranged by the School of Pharmacy, University of London, to commemorate the granting of a Royal Charter to the School. They are: "Organic Chemistry at the Cross-Roads", by Prof. J. W. Cook, regius professor of chemistry in the University of Glasgow (November 18); "Adsorption and Reaction in Monolayers and some Biological Implications", by Sir Eric Rideal, professor of physical chemistry, King's College, London (December 2); "Genetics and Medicine", by Dr. C. D. Darlington, director of the John Innes Horticultural Institution (December 15); "The Future of Pharmacy and Pharmacology", by Sir Henry Dale (February 18). The first two lectures will be delivered at the Westminster Medical School, Horseferry Road, London, S.W.1, and the remaining two at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1; the lecture hour is 5.30.

BREWING INDUSTRY RESEARCH FOUNDATION

NUTFIELD, SURREY

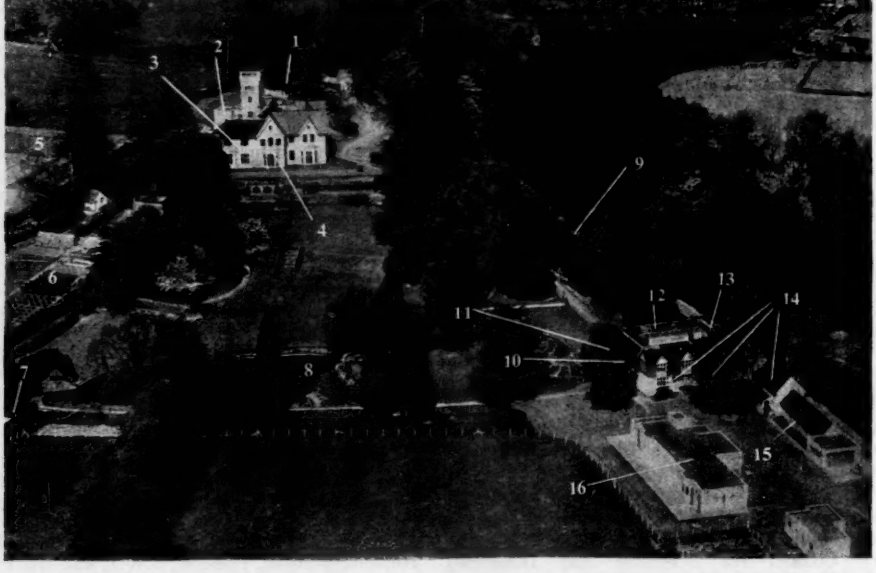
THE new Brewing Industry Research Foundation at Lyttel Hall, Nutfield, Surrey, marks the fulfilment of a scheme developed over many years by the Institute of Brewing and made possible by the generosity of the Brewers' Society. It has been specifically designed for the scientific study of brewing and fermentation generally, with particular emphasis on the fundamental aspects of the many problems involved. Lyttel Hall itself has been skilfully modified and adapted to provide an extensive range of laboratories and other facilities in attractive surroundings. With its staff of scientific specialists and technicians under the direction of Sir Ian Heilbron, the Foundation occupies a unique place among industrial research institutes.

Not unexpectedly, versatile experimental breweries provide a focal point in the Foundation. Of these the larger, of ten gallons capacity and constructed of stainless steel, is complete with air-conditioned fermentation and beer-storage rooms, bottling plant, and pasteurizing equipment.

These breweries form part of an Applied Research Division designed to study, in the light of existing knowledge, the materials and processes of brewing as used to-day, but in greater depth and with greater accuracy than is possible in a commercial production plant. Further, this Division will assist the industry by formulating new or improved methods of analysis and also engage in general technological investigations covering all aspects of brewing.

Another important function of this Division is the much-needed examination of new varieties of barleys and hops for the National Institute of Agricultural Botany, Cambridge, and the hop research stations at Wye College and East Malling, Kent, as a preliminary measure of their brewing value. These tests include brewing trials of the more promising samples, and are of great value to the plant-breeder as they permit comparative tests to be made on small quantities of materials, thus saving valuable time and acreage.

The empiricism which for long characterized the traditional industries—and is, it must be borne in mind, still dominant in brewing—must inevitably be succeeded by scientific knowledge if full economy in the use of raw materials and complete control of operations is to be achieved. With this background, a wide range of studies is in progress in the other two main divisions of the Foundation. Of these, that devoted to microbiology forms a self-contained unit of three laboratories with a complete range of ancillary service rooms in which the most exacting studies of yeast and brewing bacteria can be carried out. The problems here are formidable, and of necessity begin with a survey of the almost unexplored field of British primary yeasts, a survey rendered peculiarly arduous by the difficulty of adequately characterizing and differentiating such yeasts. Similar difficulties complicate the complementary study of 'wild' yeasts—those adventitious



Brewing Industry Research Foundation, Lyttel Hall. 1, Lodge; 2, model brewery; 3, administration offices; 4, main experimental block; 5 and 6, kitchen gardens; 7, swimming pool; 8, ornamental lake; 9, Cooper's Hill Road; 10, electrophoresis laboratory; 11, ultracentrifuge laboratory; 12, light-scattering laboratory; 13, mechanics' workshop; 14, residential cottages; 15, ancillary workshops; 16, canteen

contaminants which often have a deleterious effect on the beer. Again, beers are commonly susceptible to attack by certain types of bacteria, and although our knowledge here is more extensive than with the 'wild' yeasts, there is still need for further systematic study.

In this connexion the preservative action of hop resins assumes outstanding importance. Renewed attention is being given to means of estimating this effect by appropriate microbiological assay, a problem of peculiar difficulty because of the desirability that any test should reflect actual brewing conditions. The microbiological laboratories are also engaged on miscellaneous research such as the systematic examinations of the potential effects of selective herbicides and other agricultural chemicals on the malting quality of barley. Attention is also being directed to genetic studies on yeast, and to the possibilities of yeast hybridization. While many of these topics are of outstanding scientific interest, it must be emphasized that considerable research effort must perforce be devoted to essential but comparatively unspectacular groundwork. The need for this acutely reflects the sparse attention which has hitherto been paid to the scientific study of industrial microbiology, especially in Great Britain. For this reason an institute in which this largely neglected field receives prominence assumes special significance in view of the present meagre university facilities available for such studies.

Finally, mention should be made of the fact that in 1951 the Foundation undertook the important responsibility of maintaining the National Yeast Culture Collection. Some two hundred organisms were originally inherited from the National Collection of Type Cultures, and a further hundred and sixty yeasts of special interest have since been added. Work on the re-authentication of the cultures is already in progress, one-third of the total having been checked. Over the past year, nearly two hundred requests for yeasts have been received both from Britain and from abroad, and it is expected that this figure will increase as more yeasts are added to the Collection and its uses become more widely recognized. It will be appreciated that the National Yeast Culture Collection provides a service which extends far beyond the limits of the brewing industry.

The Chemical Division, which constitutes the third main section, comprises an extensive range of laboratories in which liberal facilities are provided for detailed research in the field of the industry's operations. Much thought has been given to the equipment of these laboratories, in which are installed all the apparatus, instruments and plant necessary to keep abreast of modern advances and techniques throughout the world. For example, the physical-chemical laboratories include the latest type of air-driven ultracentrifuge, electrophoresis apparatus and light-scattering equipment, all indispensable for immediate and long-term research.

The research programme covers the chemistry and biochemistry of the raw materials used in brewing and of the changes which they undergo during the various stages of the brewing process. Of these malt is pre-eminent, providing as it does the substance of beer, while hops supply the flavouring and preservative principles. An important early stage in malting consists of steeping the stored barley in water, an operation which it is now recognized results not merely in the uptake of water, but also in the simultaneous removal of a miscellany of substances. Among the latter are compounds which prevent or retard the normal germination of the grain. The isolation and study of these inhibitors are of considerable importance, for their planned use may conceivably lead to a higher degree of control of malting than has hitherto been possible; this aspect is now being investigated by means of specially designed experimental maltings. The barley grain is primarily a store-house for starches and proteins which are ultimately converted by specific enzymes into simpler compounds, such as dextrins and sugars on one hand and peptides and amino-acids on the other. A considerable effort is being devoted to the detailed study of these materials in barley, malt and wort, as well as to other constituents of the raw materials, notably pectins and tannins. Attention is also being given to the major constituents of hops, more particularly the resins: although the importance of these has been appreciated for years, their full significance has still to be elucidated. This is evident as a result of the application of new techniques to their examination, whereby unsuspected constituents have been revealed.

In addition to these specific studies, many other brewing problems will ultimately only be interpreted as a result of fundamental scientific research. The formation of a 'head' on beer is thought to be associated with the presence of residual proteins; but their identification is still lacking and, moreover, there is complete ignorance of the physics and physical chemistry underlying the phenomenon. Again, the deposition of part of the residual proteins after processing frequently gives rise to the formation of an undesirable haze in the finished beer, and this is being given precise study in the hope ultimately of limiting the incidence of the responsible proteins.

In addition to its laboratory facilities, the Foundation houses the largest specialized brewing library in Great Britain. As part of its functions, it prints and distributes monthly to brewers throughout the country a bulletin of current literature which surveys, without abstracting, all incoming journals, thereby giving the brewing scientist notice of an article within four to six weeks of publication. The library also supplies on request photo-copies of scientific literature, a service which fills a long-felt want and is much appreciated.

This brief survey will serve to demonstrate that the Brewing Industry Research Foundation has not been set up solely to serve the immediate needs of an industry in respect of routine control and *ad hoc* problems, but equally for the prosecution of basic research, without which a full understanding of the vital processes involved can never be attained. The Director, appreciating the breadth of the field which must be covered and the many kinds of scientific experience required for such a task, has wisely taken steps to foster contacts with many university departments and, as occasion demands, to initiate therein extra-mural work.

The visitor to Lyttel Hall is left with a deep impression of an organization which, in its conception and in its whole scientific outlook, is destined not only to contribute substantially to industrial progress, but also, by its own contributions to fundamental knowledge, to take its place as a research centre worthy of the best traditions of Great Britain.

ROYAL SOCIETY OF CANADA

MEETING AT LAVAL UNIVERSITY, QUEBEC

THE Royal Society of Canada held its annual meeting at Laval University, Quebec, during June 2–4. In Section III (Chemical, Mathematical and Physical Sciences) of the Society, the following new Fellows were elected: P. E. Gishler, L. Katz, W. B. Lewis, D. W. R. McKinley, P. Scherk and H. L. Welsh. Dr. G. Herzberg gave his presidential address on "Forbidden Transitions in Diatomic Molecules". This was one of three interesting papers in a symposium on forbidden transitions. The others were "Forbidden Transitions in Atoms", by A. G. Shenstone, and "Forbidden Transitions in Nuclei", by L. G. Elliott.

About a hundred papers were presented before the sub-sections—chemistry, mathematics, astrophysics and spectroscopy, nuclear physics, meteorology and other branches of physics.

Chemistry. The programme of the chemistry subsection consisted of a series of papers in organic chemistry (P. E. Gagnon *et al.*) and several in physical chemistry. The photolysis of azomethane has been investigated over the temperature-range 25°–190° C. (M. H. Jones and E. W. R. Steacie). Experiments on the photolysis of deuterated methylamines have shown that both the C—H and N—H bonds are ruptured (J. S. Watson and B. deB. Darwent). Various forms of deuterated pentanone-3 have been synthesized (L. C. Leitch and A. T. Morse). The assignments of certain infra-red absorption bands between 1,350 and 1,475 cm.$^{-1}$ to the bending vibrations of the C—H bonds of methyl and methylene groups located at specific positions in the molecule have been confirmed in forms of deuterated pentanone-3 (B. Nolin).

Mathematics. Three papers were presented in algebra and number theory, eight in analysis, and two in geometry. The significance of the work presented and the general interest and enthusiasm made this meeting the most outstanding of any yet held by the mathematics sub-section. It was generally agreed that the upsurge of activity on the part of Canadian mathematicians is due to the stimulus of the biennial seminars of the Canadian Mathematical Congress and especially to the influence of the Summer Research Institute.

Astrophysics and Spectroscopy. The astronomical papers included a discussion of the determination of the masses of eclipsing binaries, the study of interstellar matter, the investigation of the line profiles of *Be*-type stars, and the development of new techniques for the determination of time. The orbital elements of the exceptionally massive eclipsing system, H.D. 228854, have been deduced (J. A. Pearce). These stars are of special class *O* 7 with temperatures of 33,000° K. The orbital inclination is nearly 90°, and the relative orbital velocities are exceptionally large (710 km./sec.). The combined mass is seventy times the sun. A new catalogue of 1,346 variable stars in globular clusters has been prepared (Helen S. Hogg). Investigation of the absorption lines of the eclipsing stars Zeta Aurigæ when light of the hot star traverses the atmosphere of the larger and cooler companion has provided evidence of major prominence activity of irregular character (A. McKeller and R. M. Petrie). The intensities of interstellar sodium and calcium lines for 142 early-type stars have been used to derive a relation between distance and intensity (C. S. Beals).

Relatively high-dispersion spectra of the aurora have been obtained in the region 3300–8900 A. (W. Petrie). The near-ultra-violet emission bands of the N_2^+ molecule support the value 9·75 eV. for the dissociation energy (A. E. Douglas). The rates of change of polarizability with respect to internuclear distance have been found from the ratio of the intensities of Raman and Rayleigh scattering in gases (E. J. Stansbury, H. L. Welsh and M. F. Crawford). Experimental and theoretical results on the splitting of nuclear magnetic resonance absorption lines in single crystals by the interaction of the nuclear electric quadrupole moment with the electric field gradient within the crystal were reported (G. M. Volkoff).

Nuclear Physics. A heavy and varied programme of nuclear physics papers on heavy cosmic primaries in photographic emulsions, photonuclear reactions, neutron physics, radioactive nuclides, and mass spectrometry was presented.

Several papers on neutron physics from the Chalk River Laboratory will be briefly reviewed. Work on the resonant scattering of slow neutrons by samarium, gadolinium, europium, dysprosium and cadmium was reported. The scattering and total cross-sections of cadmium in the resonance region accurately obey the Breit–Wigner one-level formulæ. The total cross-section at resonance is 7,900 barns (B. N. Brockhouse). The neutron capture γ-ray spectra from the even-charge nuclei titanium, chromium, iron, nickel and zinc, and from the odd-charge nuclei scandium, manganese, cobalt and copper, were shown and discussed in terms of nuclear shell theory (B. B. Kinsey and G. A. Bartholomew). The angular distributions of prompt fission neutrons with respect to the direction of motion of the light and heavy fragments from the thermal neutron fission of uranium-233, -235 and plutonium-239 show that the neutron emission probability is 30 per cent greater for the light fragment (J. S. Fraser and J. C. D. Milton). The neutron capture cross-section for $^{59}Co(n,\gamma)^{60m}Co$ (10·7 min.) was reported as 19 barns (N. Moss and L. Yaffe). The nuclide radium-227, produced by the $^{226}Ra(n,\gamma)^{227}Ra$ reaction with a cross-section of 22 barns, is a β-emitter with a half-life of 41·2 min., a maximum energy of 1·30 MeV., and γ-rays of approximately 291 and 497 keV. (J. P. Butler and J. S. Adam). A curious time behaviour of positons annihilated in liquids and solids was reported. In metals and several other materials, positons are annihilated with a single mean life-time of about 2×10^{-10} sec. In other materials (for example, water, ice) two distinct life-times were observed—about 3×10^{-10} sec. and 2×10^{-9} sec. (R. E. Bell and R. L. Graham).

Papers on the radioactive properties of neutron-deficient nuclides, cadmium-105 and -104, silver-104, xenon-123, -122 and -121, produced by proton bombardment in the McGill University cyclotron, were read (J. S. Foster, F. A. Johnson and D. E. Tilley). The X-rays from the 70-MeV. synchrotron at Queen's University have been used to study depth–dose relations in a 'Plexiglas' phantom, the absorption of 17·5-MeV. X-rays in various absorbers with the aid of $^{63}Cu(\gamma,n)^{62}Cu$ as detector, and the production and

cross-sections of photonuclear reactions such as the (γ,n) reactions in carbon-12, copper-63, silver-107 and molybdenum-92 and the reactions $^{12}C(\gamma,3\alpha)$ and $^{16}O(\gamma,4\alpha)$ (J. A. Gray *et al.*). The 25-MeV. betatron at the University of Saskatchewan can be held constant to 5 keV. at a pre-selected energy. Photo-activation curves have been obtained which show a fine structure that is attributed to absorption by individual levels in the reacting nucleus. The ratios of the cross-sections for the (γ,n) reactions leading to the ground and isomeric states in bromine-80 and molybdenum-91 have been measured and related to the spins of the reacting particles (L. Katz, R. N. H. Haslam *et al.*). Excellent agreement with experimental results on the capture of electrons by protons in hydrogen is obtained if both the ion – nucleus interaction and the electron – ion interaction are included as perturbations in a calculation using the Born approximation (J. D. Jackson and H. Schiff).

Other Branches of Physics. Papers in meteorology included a discussion of the conditions for the production of low-temperature fog (W. L. Godson), a correlation between types of snow crystal and the temperature at the height of formation (L. W. Gold and B. A. Power), and evaluation of fluctuating radar weather echoes (J. S. Marshall and W. Hitschfeld). A method for measuring sub-surface velocities in the Gulf Stream was described (E. E. Watson). A flow-meter, utilizing the cooling of a thermistor element, has been found suitable for measurement of small velocities in liquids (A. D. Misener).

A number of papers were presented on the properties of dielectrics, theory of diffraction, sources of sound, vibration of plates, infra-red detection, and an absolute measurement of the ohm. The failure of the Clausius–Mosotti equation for certain artificial dielectrics was explained in terms of the random distribution and shape of the metallic particles (H. E. J. Neugebauer). Discrepancies between diffraction theories and measurements close to a circular aperture under the influence of a plane acoustic wave have been traced to rapid oscillations in field intensity within the aperture (G. Bekefi). An improved method of calculating the diffraction of electro-magnetic waves by small apertures and scattering by small conducting bodies was reported (A. F. Stevenson). Calculations and observations have been made on the vibration patterns of thick barium titanate disks (R. R. Aggarwal and E. A. G. Shaw). The usefulness of physical theory in solving engineering problems was well demonstrated in a study of chopper-type sources of sound for fog-horns and air-raid sirens (G. J. Thiessen).

Three papers on low-temperature and solid-state physics were read (D. K. C. MacDonald). By suitably modifying a Collins helium liquefier, continuous measurements of electrical resistances of metals over a wide range of temperature have been made. The variation of characteristic temperature has been examined and carefully compared with the corresponding calorimetric data. The problems of anharmonicity in lattice vibrations and of melting are of particular interest, together with the adequacy or otherwise of the Debye model. The anomalous minimum of electrical resistance found at about 10° K. in copper has been systematically investigated with specimens containing controlled small percentages of tin, silver, nickel, lead, bismuth and carbon. Scattering cross-sections can be deduced from the residual resistances. B. W. SARGENT

EMPLOYMENT PROBLEMS OF DISABLED YOUTH IN GLASGOW

INCREASING concern about the employment of the disabled led, in 1944, to the passing of the Disabled Persons (Employment) Act. It was provided in the Act that the Ministry of Labour should establish and maintain a voluntary register of disabled people and that the larger firms should be obliged to employ a quota of workers who were registered in this way. The Act also gave the Ministry power to set up units to train or rehabilitate the disabled.

The practical application of these measures brought many difficulties to light and made it clear that much more detailed information was needed about the medical problems of placing disabled people in employment. In 1948, therefore, the Ministry of Labour asked the Medical Research Council to help. The Council's Occupational Medicine Committee agreed that the first necessity was to collect information about the incidence of disability and the extent to which the various forms of disability interfered with employment, and on its recommendation the Council set up a special Committee on the Resettlement of the Disabled.

A memorandum has now been prepared recording an investigation which was carried out under the ægis of this Committee into the employment experience of two groups of young people in Glasgow; one, a group of registered disabled, the other made up of children who had been to special schools for the physically handicapped*.

In the first group, 683 young persons were registered as disabled and, of these, 104 were not covered by the investigation for various reasons. Of the remaining 579, 146 had infective and parasitic diseases and 164 had diseases of the nervous system. About 18 per cent of the group were found to be unemployed and, of those in work, the majority were employed as semi-skilled manual workers, although quite a number were employed as skilled workers in crafts like boot repairing, cabinet making, market gardening, painting, watch repairing, upholstering, glazing, sheet metal work, baking and bookbinding. Unemployment was noticeably high among the group disabled by diseases of the nervous system; this group included epileptics and congenital paraplegics. The groups disabled by tuberculosis and mental defect showed degrees of unemployment that were substantially above the average. The groups disabled by malformations, poliomyelitis, diseases of the ear and of bones all showed low unemployment-rates. Many of the young people disabled by congenital malformations, accidents, circulatory diseases and poliomyelitis were engaged in non-manual work, while a relatively high proportion of those disabled by poliomyelitis and deafness secured skilled manual work.

The general employment picture was most favourable among those disabled by poliomyelitis and deafness. In the former group this is probably because the disability is not progressive, seldom affects more than one member of the family, and does not often involve the loss of many years schooling. There is a belief that the character of the poliomyelitic patient tends to be robust and free from self-pity. In this survey the way in which they regarded their disability was outstandingly healthy

* Employment Problems of Disabled Youth in Glasgow. (London: H.M.S.O.) 3s.

and free from emotion; many drove themselves hard in their efforts to achieve independence.

Another, and in many ways complementary, aspect of the employment problem for disabled youth concerns the number of jobs which a boy has held since registration; thus the high unemployment-rate of the seventy-two who were disabled by conditions affecting the nervous system was accompanied by frequent changes of job. Those disabled by bone diseases also had a high rate of job turnover; but they did not have so much long-continued unemployment.

The most stubborn resettlement problem in the whole survey centred around the seventy-two young people who were disabled by conditions affecting the nervous system. Twenty-six of them were epileptics and forty-two have been paralysed since birth, with disabilities ranging from the involvement of one limb to hemiplegia and diplegia with athetosis. The epileptics showed a fairly uniform picture of unemployment unless medical treatment could control their fits. "Until that happens the epileptic often lives the life of an outcast and is likely to become intensely frustrated and the despair of his family." The only other group approaching the bad employment record of the "nervous system" group was that of the forty-eight mentally handicapped children, of whom forty-three had been educated at special schools for the educationally retarded. The parents of these young people agreed that work of some sort was of great value and that a few weeks of idleness after leaving the discipline of school might be fatal to the future of the youth and render him unemployable.

The most searching criticism of the Disabled Persons (Employment) Act concerned the difficulty, or even the impossibility, of obtaining training courses which were still advertised. The Ministry of Labour and National Service arranged training for twenty-four (4 per cent) of the disabled young people and in ten cases it was given at a Government training centre. In three cases training was given in private or local education authority commercial colleges: two took a general commercial course and one shorthand and typing. The remaining eleven were trained under a scheme of grant by employers approved by the Ministry. At the time of the survey, only 153 youths of the group of 579 were serving an apprenticeship or undergoing a period of training.

The unemployment-rate of these trainees was low and their job stability high, for, at the time of the survey, thirty of the 115 were still holding the same job as they had had when they registered; the great majority of the others had not been employed at the time of registration.

During the survey the young people were asked if they had been given any special advice when they left school regarding suitable employment. The great majority answered "no", though they occasionally recollected that "a teacher had complimented them on their schoolwork and suggested that they should take up art or the like".

Of the social factors affecting the employment of these disabled young people, inadequate housing was found to be of the greatest significance; 113 of the disabled young people included in the survey were existing under conditions that could only be described as appalling. It was also shown that, where there was a high incidence of paternal unemployment, unemployment was prevalent among the children also.

In the second survey, inquiries were made into the employment experience of 408 young people who had previously left schools for physically handicapped children; the findings of the observers were generally similar to those in the first series of the investigations, despite the fact that only 30 per cent in the section group were officially registered as disabled.

The bulletin also contains an account of the work of the Danish Invalidity Court. During the years 1938–44 some 10,000 notifications of "invalidity" were received by the Court, and during the same years 3,167 disabled Danes received "vocational measures" under the auspices of the Court: 1,296 of these had started training before the age of eighteen. From this and other data it would appear that the proportion of disabled young people who receive vocational training is considerably higher in Denmark than in Great Britain.

The general conclusion of the Medical Research Council's Occupational Medicine Committee is that "it is impossible to view with other than apprehension the circumstances disclosed by this study of the welfare of disabled young people. The extent of unemployment and, perhaps more important, the extent of long-term chronic unemployment, and the high proportion of the employed who are engaged in unskilled work which is often grossly unsuitable and likely to lead to physical breakdown or prolonged idleness—these are sinister findings, especially when viewed against the general background of full employment in the past few years. Failure to settle young people of this age group in suitable work must inevitably make a major contribution to the vicious, hard core of unemployment in later years".

Apart from the overriding need to improve basic living conditions, particularly housing, and to harness all the resources of medicine for the prevention of disease, the Committee makes four suggestions which would help to settle disabled young people satisfactorily in employment. It recommends mitigation of the gross educational lack that adds to the difficulties of so many of these young disabled people; adoption of energetic steps to secure satisfactory settlement before the young person begins to drift; the provision of adequate and suitable training courses for disabled young people; and intensive medical and surgical treatment where necessary and the provision of any necessary medical aids or surgical appliances.

ENZYMIC DEGRADATION OF PECTIC ACID AND THE COMPLEX NATURE OF POLYGALACTURONASE

By AUDREY AYRES, J. DINGLE, A. PHIPPS, W. W. REID and G. L. SOLOMONS

Research Department, H. W. Carter and Co., Ltd., Coleford, Glos.

THE pectic enzymes produced by *Aspergillus fœtidus*, Thom and Raper, when the organism is grown on solid bran media [(*S*) type], are different from those produced by growth in submerged culture in liquid media [(*D*) type]. The (*D*) preparations have an optimum *p*H of 5·3 on sodium pectate as

substrate, the (*S*) type 4·5. Both types of enzyme reduce the viscosity of pectic acid, until no precipitate is given either with ethanol or calcium ions, and reducing groups are formed simultaneously.

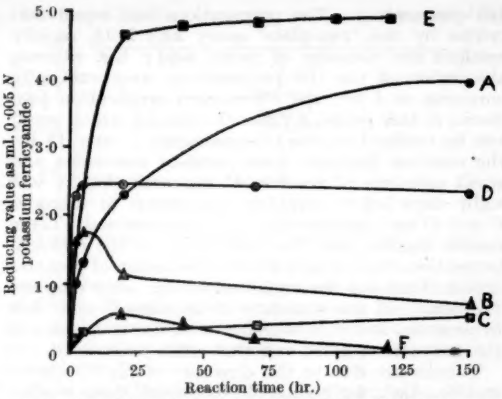
The uronides produced have been separated by paper chromatography using ethyl acetate – acetic acid – water mixtures. Using the original solvent mixtures of Jermyn and Isherwood[1], galacturonic acid and four spots, *A*, *B*, *C* and *D*, were obtained (*R* values for galacturonic acid 1·00, 0·80, 0·58, 0·33 and 0·11 respectively). Each spot reacted as an acid when the dry chromatogram was sprayed with bromophenol blue, and as a reducing substance when treated with *p*-anisidine hydrochloride. By increasing the acetic acid content of the solvent, four other uronides larger than *D* were resolvable. Substances *A* and *B* which occur only in small amounts and have a transitory existence have not yet been identified. Jermyn and Tomkins[2], in a chromatographic study of pectic enzyme action, demonstrated the formation of a series of uronides. An examination of a *Botrytis* bran culture from Dr. Tomkins indicates that *C* and *D* are the same as the 'di-' and 'tri-uronides' of Jermyn and Tomkins.

The calcium salts of uronides *C* and *D* are precipitated by 60 per cent ethanol and can be obtained free from galacturonic acid. The lead salt of *C* is appreciably soluble in water, the lead salt of *D* is insoluble and a separation can thus be achieved. Preliminary studies of the reducing value of *C* and *D* by the alkaline hypoiodite method indicate they are the di- and tri-uronides. A recent paper[2a] shows that a polygalacturonase type enzyme from a yeast produces two compounds with properties similar to *C* and *D*.

The action of (*S*) preparations on pectic acid is characterized by a rapid liberation of reducing groups, with the simultaneous destruction of the colloidal properties of the substrate; the reaction curve then shows a sharp change to a slower rate. In the initial rapid phase, a mixture of uronides not resolvable upon the chromatogram is produced, and these are then degraded to a mixture in which galacturonic acid and *C* and *D* predominate. In the second, slower, phase of the reaction, *C* and *D* are completely converted to galacturonic acid. With (*D*) preparations, the large uronides first formed are converted to a mixture containing only *C* and *D*, with small amounts of galacturonic acid; the reaction then ceases, although enzyme active against pectic acid is still present.

For chromatographic analysis, 0·05 ml. aliquots of enzyme substrate mixture were run in duplicate together with duplicate galacturonic acid markers on Whatman No. 1 paper with ethyl acetate – acetic acid – water mixtures for 18 hr. Papers were dried in air, sprayed with bromophenol blue, and appropriate spots dissected, eluted into dilute alkali and estimated by the micro-ferricyanide method. Reducing value of galacturonic acid markers: recovered 95–102 per cent; reducing value of uronides + galacturonic acid recovered in Exps. 1–3, 95 per cent.

The marked difference between the action of (*D*) and (*S*) preparations may be seen from quantitative chromatograms (see diagram). In Expt. 2, only uronides *C* and *D* and galacturonic acid were detectable in the 20-hr. chromatogram. In Expts. 1 and 2, the amounts of the (*S*) and (*D*) preparations were selected so that their activities on the colloidal properties of pectic acid were the same, that is, their



Chromatographic analysis of the action of (*D*) and (*S*) type preparations on sodium pectate at *p*H 5·5.

Expt. 1. Action of 50 mgm. (*S*) type preparation on 50 ml. of 2 per cent sodium pectate. *A*, Galacturonic acid produced; *B*, higher uronides produced.
Expt. 2. Action of 800 mgm. (*D*) type preparation on 50 ml. of 2 per cent sodium pectate. *C*, Galacturonic acid produced; *D*, higher uronides produced.
Expt. 3. Action of 800 mgm. (*S*) type preparation on 50 ml. of 2 per cent sodium pectate. *E*, Galacturonic acid produced; *F*, higher uronides produced.

activities were equal both by 'cup-plate'[3] and viscometric[4] methods. Higher concentrations of the (*S*) preparation, Expt. 3, resulted in a more rapid conversion of pectic acid to galacturonic acid. From the action of (*D*) preparations on pectic acid, samples containing only *C* and *D* were obtained in a yield equivalent to 75 per cent of the uronic anhydride content of the original substrate, and the mixture of *C* and *D* was completely converted to galacturonic acid by (*S*) preparations at a *p*H optimum of approximately 3·5.

Polygalacturonase[5] has been postulated as an enzyme degrading pectic acid to galacturonic acid, and chromatographic evidence[2] appeared to support this view. From the present findings, it is clear that the degradation of pectic acid to galacturonic acid involves at least two enzymes. One of these (I) degrades pectic acid to uronides *C* and *D*, and another, (II), is necessary to convert these uronides to galacturonic acid. The (*D*) preparations consist of the former enzyme, and (*S*) preparations (and various commercial samples examined) are mixtures of the two. It is not known whether the enzyme (II) attacking the uronides *C* and *D* can also degrade higher uronides, and it is not therefore possible to define assay methods for enzymes (I) and (II). However, by carrying out parallel assays with both pectic acid and a mixture of *C* and *D* as substrates, it can be shown that (*D*) preparations attack pectic acid only, whereas (*S*) preparations attack both substrates; but the ratio of the two activities varies widely with the preparation.

The (*D*) preparations, when heated at 100° C. in 10 per cent w/v magnesium chloride for 10 min., retain about 30 per cent of their activity, and in their thermostability resemble the pectic 'depolymerase' of tomatoes[3]. A 'depolymerase' isolated from *Neurospora*[7] has similar properties to the (*D*) preparation. Barratt (personal communication) has shown by paper chromatography that a number of uronides accumulate during the action of the *Neurospora* enzyme. A *Neurospora* preparation from Dr. Barratt was compared in these laboratories with a purified

(*D*) preparation. The preparations had equal activities by the 'cup-plate' assay and both rapidly reduced the viscosity of pectic acid; but whereas the action of the (*D*) preparations was practically complete in 4 hr., the *Neurospora* preparation produced in this period a mass of uronides which could not be resolved on the chromatogram; after 18 hr. the reaction products were partially resolvable and small amounts of uronide *D* appeared, but it was eight days before complete conversion to uronides *C* and *D* and galacturonic acid was obtained. These results suggest that the destruction of the colloidal properties of pectic acid and the formation of uronides *C* and *D* are not accomplished by the same enzyme.

A study of the structure of uronides *C* and *D* is in progress, and this, together with the properties of the enzymes, will be reported when completed.

Thanks are due to the directors of H. W. Carter and Co., Ltd., for permission to publish these results, to Dr. Tomkins for a sample of *Botrytis* bran and to Dr. Barratt, who kindly sent us prior to publication the manuscript of a paper on the 'depolymerase' of *Neurospora* and a sample of this enzyme. [May 16.

Note added, October 22. The (*D*) preparations contain two enzymes. The *p*H-activity curves of these preparations on pectic acid show two optima, at *p*H 5·3 and at 3·5. The former peak is due to enzyme (I*a*) which may be inactivated at *p*H 5·0 and 50° C. for 30 min., and attacks pectic acid and pectin (without simultaneous demethylation) with a rapid destruction of the colloidal properties of the substrate and the formation of a "low molecular weight polyuronide"[7]. The peak at *p*H 3·5 is given by enzyme (I*b*), which attacks pectic acid and lower demethylated uronides with a slow destruction of the colloidal properties and a rapid liberation of galacturonic acid and uronides *C* and *D*. Whereas the concentration of enzyme (I*a*) is approximately equal in the (*D*) and *Neurospora* preparations used above, the content of (I*b*) in *Neurospora* is only 5 per cent of that in the (*D*) preparation.

Through the courtesy of Dr. H. J. Phaff we have shown that *C* and *D* are chromatographically identical with his di- and tri-galacturonic acids. (A. P., W. W. R., G. L. S.)

[1] Jermyn, M. A., and Isherwood, F. A., *Biochem. J.*, **44**, 402 (1946).
[2] Jermyn, M. A., and Tomkins, R. G., *Biochem. J.*, **47**, 437 (1950).
[3,6] Phaff, H. J., and Luh, B. S., *Arch. Biochem.*, **36**, 231 (1952).
[5] Reid, W. W., *Nature*, **166**, 569 (1950).
[4] Reid, W. W., Abstracts of Communications, 1st Int. Congress Biochem., Cambridge, 287 (1949).
[5] Kertesz, Z. I., "The Pectic Substances" (London: Interscience Publishers, Inc., 1951).
[6] McColloch, R. J., and Kertesz, Z. I., *Food Tech.*, **3**, 94 (1949).
[7] Roboz, E., Barratt, R. W., and Tatum, E. L., Abstracts American Chem. Soc., 118th Meeting, Chicago, 1950; *J. Biol. Chem.*, **195**, 459 (1952).

STREAMING POTENTIAL AND ELECTRO-OSMOSIS

A Model for the Mechanism of Streaming Potential

ALTHOUGH considerable efforts to explain experimental phenomena on the basis of the classical theory of streaming potential have been made, it would appear that the model upon which the theory is based is defective. A more comprehensive theory might possibly be based upon a model described here. In this model it is postulated that: (1) the radial distribution of charge varies smoothly along the capillary during steady-flow conditions; (2) there is no circulation of ions within the fluid.

These postulates are deduced from the following experimental observations. (*a*) A system comprising an arrangement of solid–liquid interfaces at rest is, as a whole, electrically neutral. (*b*) A (thermodynamic) potential generally exists at solid–liquid interfaces and can be detected with a standard electrode. (*c*) Relative movement between solids and liquids is generally accompanied by the setting up of a potential difference along the direction of flow. (*d*) This potential difference tends to a steady value for a given set of flow conditions.

Thus, since a capillary full of liquid receives no charges from outside the system, it follows that any electrical effects during liquid flow must arise from a re-distribution of charges which are present in the stationary state.

In order that any electrical effect may arise, there must be an initial radial distribution of charges in the stationary condition which is disturbed by the onset of liquid flow. This radial distribution can arise in three ways: a transfer of charge from the surface to the liquid; a transfer of charge from the liquid to the surface; an exchange of charges between the liquid and solid. When equilibrium is reached after the separation of charges, the radial distribution of charge within the liquid is determined by a balance of the forces acting on the ions, as a result of the interaction between the ions and the charged wall and the mutual interaction between the ions, the form of the distribution being in accordance with the equations of Poisson and Boltzmann. Axial flow of the liquid within the tube, under the influence of a hydraulic gradient, will tend to strip the diffuse layer at the inlet end of the capillary. The parabolic distribution of flow velocity will cause the rate of removal of charge to vary with the radius, so that a tapering of the diffuse layer will occur along the length of the tube.

Since it is known that the streaming potential reaches a steady value for a given set of flow conditions, it follows that the stripping of the diffuse layer must be counterbalanced by a restoring action. It also follows, from the constancy of the streaming potential, that, for steady conditions, the liquid flowing through the tube must be electrically neutral.

For the present purpose it is postulated that the layer is restored by both the following mechanisms: (1) Under the influence of the axial potential gradient, the ions in the body of the incoming liquid are dependent upon the sign of the charge these carry, either accelerated or decelerated, the unbalanced surplus of one sign so formed being dispersed by radial migration under the influence of the radial potential gradient and inclusion in the diffuse layer. (2) The transfer mechanism at the interface operates to replace the lost charges towards the inlet end of the tube and in the opposite direction towards the outlet end. Thus, over the whole surface of the tube, equal numbers of charges are entering and leaving the wall layer. The present analysis requires the simultaneous operation of both these mechanisms, but does not exclude the possibility of others.

Detailed analysis based on this model shows that: (1) The model leads to an expression dependent on the same variables as the classical equation.

(2) The four common electro-kinetic effects, streaming potential, electro-osmosis, cataphoresis, and sedimentation potential, can be explained.

(3) The special conductivity K_s substituted by Briggs[1] in the classical equation in place of the bulk liquid conductivity is justified.

(4) Possibly (*a*) flocculation and (*b*) dispersion may be explained on this basis.

(5) The observations of Casagrande[2] on the pressure effects arising from electro-osmosis can be explained.

(6) Deviations from Darcy's law observed by various workers can also be explained on this basis.

Acceptance of the model also leads to the conclusion that the term 'zeta potential' has no rigid meaning; and analytical treatment of streaming potential along the lines followed by Elton[3] requires reconsideration.

A full account of the work will be published elsewhere.

HORACE E. ROSE
G. MOSS

Mechanical Engineering Department,
King's College (University of London),
Strand, London, W.C.2.
June 26.

[1] Briggs, D. R., *J. Phys. Chem.*, **32**, 641 (1928).
[2] Casagrande, L., *Geotechnique*, **1**, 3 (1949).
[3] Elton, G. A. H., *Proc. Roy. Soc.*, A, **198**, 581 (1949).

Mechanism of Electro-osmosis

As indicated above, the Rose and Moss model of ionic distribution for steady streaming potential conditions suggests a similar mechanism for electro-osmotic flow.

The application of an electrical potential gradient along the length of the capillary will disturb the ionic distribution of the diffuse double-layer, at rest, resulting in a thinning down of the layer towards the inlet end of the capillary. The double-layer will be partly restored by ions of the same sign contained in the incoming liquid, and when steady flow conditions are reached, the radial distribution of ions will vary along the length of the tube. The ions of the removed double-layer are discharged at the down-stream electrode while the ions in the incoming water of opposite sign to the diffuse double-layer are discharged at the other electrode, these two ionic streams composing the current concerned in electro-osmosis as distinct from the ordinary galvanic current in the capillary. The ionic force available in the double-layer for overcoming the viscous shear resistance of the double-layer in electro-osmotic flow is proportional to the ionic concentration of the

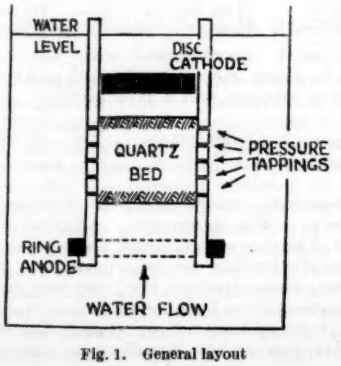


Fig. 1. General layout

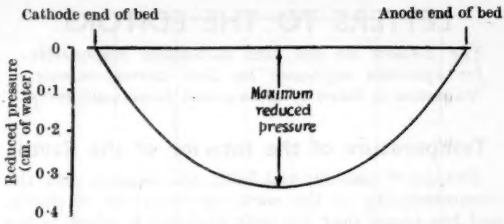


Fig. 2. Distribution of reduced pressures within the bed

double layer. In the suggested mechanism, the variation of ionic concentration along the length of the capillary means that the ionic tractive force will also vary along the capillary, being a minimum at the inlet end.

From considerations of flow continuity, the rate of liquid flow will be dependent on the mean force available in the capillary. At any point along the tube the tractive force available will differ from the mean ionic tractive force by a certain amount, and a compensating pressure gradient will be induced at that point, the size and direction of which will depend on this difference.

In streaming potential there is no removal of charge from the system, and the solid – liquid system remains electrically neutral, whereas in electro-osmosis it would be expected that the solid – liquid system should contain a deficiency of the ions of the kind forming the double-layer.

Experimental work. Experimental work has been carried out on electro-osmotic flow of distilled water through a bed of quartz powder of size ranging from 50 μ to 140 μ subject to potential gradients of up to 40 volts/cm. Measurements of electro-osmotic discharge of water and of pore-water pressures within the bed were made with no external hydraulic pressure gradient across the bed. The general layout is shown in Fig. 1.

Pressures below that of the free water at either end of the sample were measured in the bed, the distribution of these reduced pressures being of the form shown in Fig. 2, with the greatest pressure reduction occurring near the centre of the length of the bed.

A typical result was that a maximum pressure reduction was obtained near the centre of the bed of 0·33 cm. of water in a quartz bed of 4·67 cm. length under a potential gradient of 21·7 volts/cm., giving a discharge of $1{\cdot}95 \times 10^{-3}$ c.c. of water per sec. per sq. cm. of bed.

The observed distribution of pressure within the bed agrees with the suggested theory, as the tractive force would be a minimum at the inlet end of the bed (the anode end for a quartz-distilled water system) and therefore less than the mean force governing the rate of flow. A supporting or assisting pressure gradient would consequently be expected towards the inlet end of the bed, reaching a maximum value at that end of the bed, which is indeed observed in the tests. Similarly, the negative or resisting pressure gradient measured towards the outlet end of the bed would be predicted from the theory.

K. L. NASH
N. W. LISTER

Civil Engineering Department,
King's College (University of London),
Strand, London, W.C.2.
June 26.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Temperature of the Interior of the Earth

Bullen[1,2] has derived both the density and the compressibility of the earth as functions of depth, and has found that the bulk modulus k, which is the reciprocal of the compressibility $\varkappa$, is a linear function of the pressure p:

$$k = k_0 + ap. \quad (1)$$

Ramsey[3] has re-examined this relation from the point of view of the theory of solids, and his conclusions agree with those of Bullen, namely, that the linear relation (1) is valid both in the core and in the mantle below 1,000 km. Ramsey, however, found that the constant k_0 had different values in the core and mantle, although the derivative $dk/dp = a$ was sensibly the same.

In view of equation (1), it seems reasonable to suppose that a similar relationship exists between the volume coefficient of thermal expansion α and pressure p, namely, that the reciprocal of α is a linear function of p:

$$\frac{1}{\alpha} = \frac{1}{\alpha_0} + bp. \quad (2)$$

In a recent investigation on the thermal properties of the earth (based on the theory of solids), Uffen[4] has obtained values of α within the mantle, and it is found that they are in excellent agreement with hypothesis (2). It is assumed that the relation (2), like the relation (1), is valid both in the core and the mantle. The values of the constants $1/\alpha_0$ and b are found to be:

$$1/\alpha_0 = 2{\cdot}4 \times 10^4\ ^\circ\text{K.}, \quad b = 6{\cdot}2 \times 10^{-6}\ ^\circ\text{K. cm.}^2/\text{dyne}. \quad (3)$$

A theoretical investigation for the justification of (2) is in hand.

It is now possible to make an estimate of the adiabatic temperature gradient throughout the earth. The adiabatic gradient may be written

$$\frac{dT}{dp} = \frac{\alpha T}{\rho c_p}, \quad (4)$$

where ρ is the density and c_p the specific heat at constant pressure. From (2) and (4),

$$\frac{dT}{T} = \frac{dp}{\rho c_p\left(\frac{1}{\alpha_0} + bp\right)}. \quad (5)$$

Both Uffen[4] and Verhoogen[5] obtained values of the ratio α/c_p in the mantle using seismic data. Uffen found that the values of c_p were approximately constant (in agreement with Bridgman's observations at relatively low pressures), and that the variations in α/c_p were almost entirely due to variations in α. A constant value for c_p is assumed, so that from (5),

$$\ln T = \frac{1}{c_p}\int \frac{dp}{\rho\left(\frac{1}{\alpha_0} + bp\right)}. \quad (6)$$

It is estimated that variations in c_p will not affect the validity of (6) by more than 5 per cent. Since ρ is known as a function of depth (and hence of pressure), equation (6) can be integrated numerically. Hypothesis (2) is assumed to hold at all depths below 1,000 km., although preliminary investigations show that it is not likely to be much in error up to depths of 500 km. Taking T at 1,000 km. to be 3,600° K. (Uffen[4]), values of T can be estimated at all greater depths. It is found that the temperature at the boundary of the core and mantle is 4,350° K. and at the centre of the earth a little greater than 4,800° K. The increase throughout the core is thus only 500°. The results should be of considerable interest to Bullard's[6] theory of the transfer of heat from the core. Further implications of equations (1) and (2) are being investigated, and it is hoped to publish a fuller account elsewhere.

J. A. Jacobs

University of Toronto,
Toronto 5, Ontario.
June 19.

[1] Bullen, K. E., *Bull. Seis. Soc. Amer.*, **30**, 235 (1940); **32**, 19 (1942).
[2] Bullen, K. E., *Mon. Not. Roy. Astro Soc., Geophys. Supp.*, **5**, 355 (1949); **6**, 50 (1950).
[3] Ramsey, W. H., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **6**, 42 (1950).
[4] Uffen, R. J., Ph.D. thesis, Univ. of West. Ont., Canada.
[5] Verhoogen, J., *Trans. Amer. Geophys. Union*, 32–1 (1951).
[6] Bullard, E. C., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **6**, 36 (1950).

Effect of Water Vapour on Explosions of Carbon Monoxide

It is well known that the low-pressure explosion of carbon monoxide – oxygen mixtures is characterized by an upper and a lower pressure limit of explosion at a particular temperature. We find that it is also characterized by an upper and a lower pressure limit for a glow, accompanied by slow oxidation, to occur.

Garner and Gomm[1], Cosslett and Garner[2] and Hadman, Thompson and Hinshelwood[3] found water vapour to have no effect on the lower explosion limit. In accordance with this, we find that water vapour has no effect on the lower glow limit. Hadman *et al.*[3] also concluded that water vapour had no effect on the upper explosion limit. We cannot confirm this conclusion. Water vapour raises both the upper glow limit and the upper explosion limit. As a consequence it reduces the temperature of the tip of the explosion peninsula.

Hadman *et al.*[3] made their statement because, using a dry mixture and a static method, they obtained the following values for the upper explosion limit:

650° C.	67 per cent O_2.	P = 240 mm.
680° C.	67 „ „ O_2.	P = *c.* 360 „

and compared these values with the following, obtained by Kopp, Kowalsky, Sagulin and Semenoff[4], using a wet mixture and a flow system:

650° C.	90 per cent O_2.	P = 260 mm.
	33 „ „ O_2.	P = 190 „
680° C.	33 „ „ O_2.	P = *c.* 460 „

The comparison, made in 1932, is scarcely very satisfactory. The agreement is neither extensive nor exact. The comparison ignores any possible difference in results for flow and static systems. Examples are known where ignition temperatures determined in flow systems have been high relative to determinations in static systems. Nevertheless, the statement that water vapour has no effect on the upper ex-

plosion limit has been repeated as a fact right through the literature down to the present time (for example, ref. 5, p. 268; ref. 6, p. 70; ref. 7, p. 23; ref. 8, p. 78). It appears that from 1932 to the present study no one set of investigators has carefully determined the upper explosion limit in both wet and dry mixtures and under otherwise similar conditions.

In the literature prior to 1932, there are several observations which should have warned workers against accepting the conclusion of Hadman *et al.* Dixon[9], long ago, found that water vapour has a sensitizing effect on the spark ignition of carbon monoxide – oxygen mixtures at atmospheric pressure. Prettre and Laffitte[10] showed that addition of 5 per cent water vapour lowered the spontaneous ignition temperature at atmospheric pressure by 20°–30° C. Observations by Topley[11] contain a clear statement that the upper pressure limit of explosion depends upon the concentration of water vapour, and an implication that water vapour reduces the temperature of the tip of the explosion peninsula. Topley's work, however, has been completely neglected.

We should also like to mention that we have found the explosion peninsula of carbon monoxide to be expanded by small, and contracted again by large, quantities of methane. A full account of these and other observations relating to the combustion of carbon monoxide will be published elsewhere.

Note added in proof. Since this letter was submitted for publication, we have learnt that Dr. A. S. Gordon (*J. Chem. Phys.*, **20**, 340; 1952) has also found water vapour to have a marked effect in raising the upper explosion limit.

D. E. Hoare
A. D. Walsh

Department of Chemistry,
University, Leeds 2.
April 26.

[1] Garner and Gomm, *Trans. Farad. Soc.*, **24**, 470 (1928).
[2] Cosslett and Garner, *Trans. Farad. Soc.*, **26**, 190 (1930).
[3] Hadman, Thompson and Hinshelwood, *Proc. Roy. Soc.*, A, **137**, 87 (1932); **138**, 297 (1932).
[4] Kopp, Kowalsky, Sagulin and Semenoff, *Z. Phys. Chem.*, B, **6**, 307 (1930).
[5] Semenoff, "Chain Reactions" (Oxf. Univ. Press, 1935).
[6] Lewis and von Elbe, "Combustion, Flames and Explosions of Gases" (Camb. Univ. Press, 1938).
[7] Buckler and Norrish, *Proc. Roy. Soc.*, A, **172**, 1 (1939).
[8] Lewis and von Elbe, "Combustion, Flames and Explosions of Gases" (Acad. Press, New York, 1951).
[9] Dixon, *Phil. Trans. Roy. Soc.*, **175**, 617 (1884); see Bone, *J. Chem. Soc.*, 338 (1931).
[10] Prettre and Laffitte, *C R. Acad. Sci., Paris*, **188**, 1403 (1929).
[11] Topley, *Nature*, **125**, 560 (1930).

Poisoning of Oxide Cathode Emission by Oxygen

The following experiments were carried out in an attempt to determine the mechanism of the reduction of electron emission from oxide cathodes by oxygen.

Metson[1] demonstrated the reversibility of oxygen poisoning, and suggested that a possible recovery mechanism was the outward diffusion of negative oxygen ions after a poisoning attack. An attempt was therefore made to detect directly any change in the emission of oxygen ions after poisoning by using a mass spectrometer with an oxide cathode source.

The emission from mixed barium and strontium oxide cathodes at temperatures in the range 1,000°–1,200° K. was reduced to 10 per cent of its initial value by liberation of oxygen from a heated tungsten wire coated with barium peroxide. After the oxygen flow was cut off, the emission of both electrons and negative oxygen ions was studied. The following points were noted.

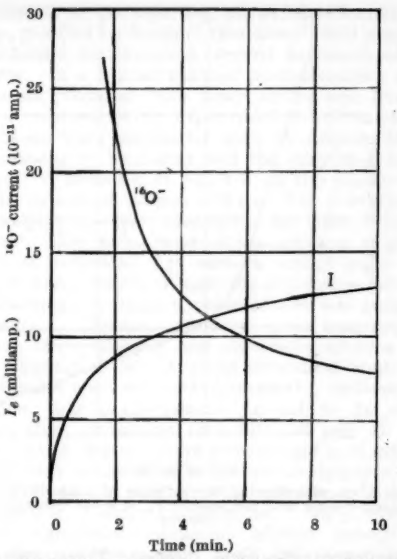


Fig. 1. Typical curves showing variation of oxygen ion current ($^{16}O^-$) and electron emission I with time, during recovery from an oxygen poisoning attack

(1) The poisoning phenomenon was completely reversible, that is, full recovery of electron emission to its initial value occurred, even after several previous attacks.

(2) The emission of ionized oxygen from the cathode increased, often by a factor of 10 or more, immediately recovery commenced, gradually falling off to its original intensity as recovery was completed (see Fig. 1). The predominant oxygen ion was that of mass 16, although traces of the ion oxygen-32 sometimes occurred.

(3) Higher activation-rates existed in the presence of larger potential gradients in the cathode coating.

(4) Poisoning experiments at varying temperatures showed: (*a*) increased sensitivity to poisoning at low temperatures; (*b*) considerably higher rates of oxygen evolution during recovery at higher temperatures.

(5) Energy distribution measurements on the oxygen ions showed that those emitted during normal operation of the cathode were characterized by the possession of energies in excess of the spectrometer accelerating voltage, suggesting formation by bombardment of a surface film of oxygen by high-energy positive ions formed in the electron gun[2,3]. Those emitted after poisoning, however, had their origin in the cathode coating itself. These results may be explained by the assumption that, on poisoning, the oxygen enters the cathode coating, reducing the emission by either (*a*) the formation of surface oxygen films on the emitting oxide crystals, or (*b*) the occupation of vacant oxygen sites (especially near-surface sites) in the oxide crystal lattice.

To determine the relative importance of the two processes under various conditions, further experiments were carried out on the effect of oxygen on electron emission and coating conductivity using

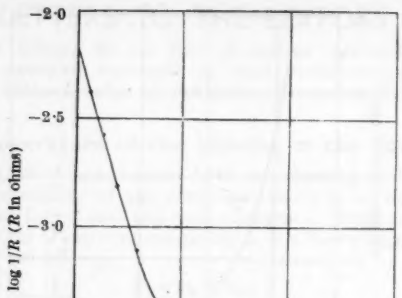


Fig. 2. A plot showing the variation of conductivity of the cathode coating with temperature T. R is the resistance of the coating

low-voltage cylindrical diodes. These valves had mixed barium and strontium oxide cathode coatings of thickness 50–100 microns with a helical nickel probe wire of diameter 0·0125 mm. embedded in the oxide layer. Conductivity measurements were made by applying up to 100 mV. between probe and base metal, in both directions. The experiments showed:

(1) Completely ohmic current-voltage characteristics providing that both cathode base metal and probe wire were efficiently treated in a hydrogen furnace to remove surface oxide films, etc., before assembly.

(2) The variation of coating conductivity with temperature T gave plots of log $1/R$ against $1/T$ consisting of two straight lines, showing the presence of two conduction processes with a transition temperature of about 700° K. in all tubes used (see Fig. 2). The low-temperature activation energy was about 0·1 eV., whereas the high-temperature activation energy was 0·8 eV. This may be explained by the suggestion of Loosjes and Vink[4] that the two processes involved are (*a*) a crystal-to-crystal conduction process, predominating below 700° K., and (*b*) a process of electron emission and absorption across the inter-crystal spaces, predominating above 700° K.

(3) On investigating the effect of oxygen on emission and conductivity, the following facts emerged: (*a*) at temperatures above 700° K., the conductivity of the coating and the electron emission were poisoned by oxygen in the same way; (*b*) at temperatures below 700° K., the conductivity was scarcely affected by the introduction of oxygen into the cathode coating, even though the electron emission was reduced to one tenth of its original value.

It seems probable, in view of the above results, that the main cause of oxygen poisoning is the adsorption of thin films of oxygen on both the outer cathode surface and the interior crystallite surfaces, reducing both emission and conductivity of the coating at high temperatures. At low temperatures, such adsorption will reduce the emission from the outer surface without appreciably affecting the conductivity of the coating, since the main contribution is by direct crystal-to-crystal conduction at temperatures below 700° K.

The experimental work was carried out in the Physical Laboratories of the University of Manchester, and I wish to thank Prof. P. M. S. Blackett and Prof. F. A. Vick for facilities and help.

A complete report on the above work is in course of preparation for publication.

A. A. Shepherd

Department of Physics,
University College of North Staffordshire,
Keele, Staffs.
April 25.

[1] Metson, G. H., *Nature*, **164**, 540 (1949).
[2] Sloane, R. H., and Watt, C. S., *Proc. Phys. Soc.*, **16**, 217 (1948).
[3] Arnot, F. L., and Milligan, J. C., *Proc. Roy. Soc.*, **A**, **156**, 538 (1936).
[4] Loosjes, R., and Vink, H. J., *Philips Res. Rep.*, **4**, 449 (1949).

Coloured 'Perspex' for Darkroom Lights

King and Ventura[1] have recently directed attention to the value of coloured 'Perspex' in the construction of filters for colorimetry, and it may be of interest to describe a similar use to which this material had been put in this laboratory.

Experimental botanists frequently require a 'physiological darkroom' in which plants and cultures may be grown with minimum disturbance from light. In practice, this amounts to employing weak, phototropically inactive light, which is commonly obtained by screening the unwanted wave-lengths from ordinary incandescent bulbs. Coloured glass obtained from glaziers seldom possesses the required transmission, and although special dyed-in-the-mass glasses are obtainable from scientific glass makers, they are (in some countries) difficult to obtain, and relatively expensive in the size required. Red 400 and Amber 300 'Perspex' have been successfully used in place of glass.

Transmissions over the relevant spectral regions, determined by a model *DU* Beckman spectrophotometer for sheets ⅛ in. in thickness, are recorded in the accompanying table.

Wave-length (A.)	Transmission (per cent) Red 400	Amber 300
5260		0·02
5360		1·5
5400		6·5
5460		26·3
5500	0·0	41·8
5800	0·0	87·1
5900	4·3	89·0
6000	24·0	89·5
6250	82·4	
6500	90·4	92·0
7000	92·0	92·3

Although there is evidence[2] for some phototropic response of chlorophyll-containing tissues to light of wave-lengths greater than 6500 A., wave-lengths greater than 5500 A. are usually accepted as being phototropically inactive to etiolated material. The most careful determination appears to be that of Johnston[3] working with coleoptiles of *Avena sativa* L. var. Culberson. He found phototropic sensitivity to be low at 5000 A.; but the threshold was not reached until 5461 A.

Red 400, which produces a light in which visual acuity is moderately satisfactory, should thus be quite safe for such material; but this would not be expected of Amber 300, which produces a light providing much easier working conditions. However, coleoptiles of *Avena sativa* L. var. Victory have shown no phototropic response to incandescent light screened through either Red 400 or Amber 300. Coleoptiles of various

ages have been exposed for periods ranging from a few minutes to 18 hr., the intensity of radiation of the red light being of the order of 4 ergs/mm.²/sec., and that of the amber light 7 ergs/mm.²/sec. It may be pointed out that the Schott filter *OG*-2 is recommended for such a purpose[4], and this filter has a transmission of 14 per cent at 5460 A.

The characteristics of Red 400 and Amber 300, taken together, are of further interest in connexion with a technique recently devised by Heath[5] for taking a series of shadowgraphs of *Avena* coleoptiles. Heath employed Kodak *RP*15 'Reflex' paper, and orange or orange-red cellulose acetate filters for producing the exposing light. The same result can be obtained more conveniently with the above 'Perspex' filters and ordinary bromide paper, since the latter is virtually insensitive to light screened through Red 400, which may therefore be used generally in the room for culture, manipulation, etc., and adequate shadowgraphs can be obtained using light screened through Amber 300 without affecting the plants. Exposures for 2 min. at the intensity recorded above are satisfactory.

The findings discussed here apply to plants cultured in red light (wave-length greater than 6000 A.) at intensities of the order of 5–15 ergs/mm.²/sec.

A word of caution should perhaps be added regarding the permanence of such filters. The manufacturers state that, after 12-months exposure outdoors, "very slight fading" occurred[6]. Insufficient experience has been gained under the conditions of an *Avena* test room (25° C. and 90 per cent relative humidity) to assess deterioration. Possibly, any deterioration could be retarded by mounting the 'Perspex' between sheets of plain glass.

L. A. T. Ballard

Division of Plant Industry,
Commonwealth Scientific and
Industrial Research Organization,
Waite Agricultural Research Institute,
South Australia.
April 18.

[1] King, E. J., and Ventura, S., *Nature*, **168**, 702 (1951).
[2] Atkins, G. A., *Ann. Bot.*, **50**, 197 (1936). Bünning, E., *Planta*, **27**, 583 (1937).
[3] Johnston, Earl S., Smith. Misc. Coll., **92** (11), 1 (1934).
[4] Went, F. W., and Thimann, Kenneth V., "Phytohormones" (Macmillan, New York, 1937). Boysen Jensen, P., translated and revised by Avery, George S., and Burkholder, Paul R., "Growth Hormones in Plants" (McGraw-Hill, New York, 1936).
[5] Heath, O. V. S., *Nature*, **168**, 950 (1951).
[6] Imperial Chemical Industries, Ltd., Plastics Division, I.S. Note No. 208.

Enzymic Splitting and Synthesis of Glutathione

The mechanism of the activation of the enzymic splitting of glutathione by glutamine—first considered specific for the amide[1]—may be interpreted as the transfer of the glutamyl moiety from glutathione to glutamine with the formation of the corresponding γ-glutamylglutamine[2–6]. Since it was considered possible that the γ-glutamylglutamine formed from glutathione and glutamine may serve as substrate for glutamotransferase, which can utilize glutamine only[7–9], a detailed study of the activation of the enzymic splitting of glutathione by L-amino-acids and peptides as well as of the effect of γ-glutamyl peptides on the splitting was undertaken. In the experiments to be reported, an extract from sheep kidney, purified by butanol treatment[10] and ammonium sulphate fractionation, served as source of the enzymes. In a similar manner potent enzyme solutions were prepared from brain cortex and liver.

In a representative experiment 6 micromoles of glutathione were incubated with 27 micromoles of the activator to be tested and the enzyme solution (20 μgm. of protein), at *p*H 8·5, in the presence of cyanide, in a total volume of 2 c.c. The liberation of cysteinylglycine was measured by the Sullivan reaction[1]. The initial rates of the splitting of glutathione as activated by various amino-acids and peptides were compared with the activation effected by glutamine, to which a value of 100 was assigned arbitrarily. Glycine, glutamic acid, asparagine, tyrosine, phenylalanine, and glycylglycylglycine activated slightly (0–30), whereas structural analogues of glutamine such as γ-ethylglutamate, methionine, ethionine, and homocysteine proved to be more efficient than glutamine (120–210) (cf. ref. 4). Of equal potency as activators were peptides of glycine in which this amino-acid, as in cysteinylglycine, was substituted in its amino-group (glutaminylglycine, alanylglycine, asparaginylglycine, leucylglycine), whereas dipeptides containing glycine substituted in the carboxyl group were weak activators (glycylglutamine, glycylasparagine, glycylleucine). Glycylglycine as well as glycylalanine—the latter being an exception to the above-described observation—proved to be potent activators of glutathione splitting (220).

When γ-glutamylglycine or γ-glutamylglutamic acid in an amount equal to that of glutamine was added in an experiment in which the amide was used as the activator, much lower colour equivalents in the Sullivan reaction were obtained at the end of the incubation than in control experiments in which no γ-peptide had been added. That we were not dealing with a competitive inhibition of the splitting of glutathione was demonstrated by the observation that the addition of a γ-glutamyl peptide, after incubation of glutathione, glutamine, and enzyme, led to a decrease of the Sullivan reaction of the incubated mixture upon further incubation. The appearance of glutathione, as measured by the glyoxalase test[11], with a simultaneous decrease in the Sullivan reaction, could be demonstrated upon the incubation of cysteinylglycine, γ-glutamylglycine, and enzyme (see table). The discrepancy between the amount of cysteinylglycine disappearing (Sullivan) upon the incubation of the dipeptide with glutamylglycine and the amount of glutathione formed (glyoxalase) is striking. The reasons for this discrepancy may be found partly in the inhibition of the utilization of glutathione in the glyoxalase test by cysteinylglycine, and partly in the conversions which glutathione undergoes under the action of enzymes which deprive it of its ability to activate glyoxalase without concomitant liberation of cysteine or cysteinylglycine. The results, although only of a qualitative nature, show that glutathione may be synthesized from γ-glutamylglycine and cysteinylglycine by an exchange reaction between the two peptides. Cysteinylglycine proves, therefore, to be as effective an acceptor of the γ-glutamyl radical as the other peptides in which the amino-group of glycine is substituted (see above). The synthesis of glutathione by an exchange reaction is of particular interest since the tripeptide can also be synthesized from the component amino-acids with the participation of

Enzymic Synthesis (from Cysteinylglycine and γ-Glutamylglycine) and Breakdown of Glutathione

	Found after incubation	
	Cysteinylglycine (Sullivan)	Glutathione (glyoxalase)
	(micromoles)	(micromoles)
(1) Glutathione	1·1	0·46
(2) Cysteinylglycine	2·3	0
(3) Cysteinylglycine + γ-glutamylglycine	1·4	0·25

(1) Glutathione 3·3 micromoles, potassium cyanide 40 micromoles, kidney protein 0·4 mgm., *M*/15 phosphate *p*H 7·4, total volume 2 ml.; 30 min. at 37°.
(2) Cysteinylglycine 2·3 micromoles (according to Sullivan reaction), potassium cyanide 40 micromoles, protein 0·2 mgm., *M*/15 phosphate *p*H 7·4, total volume 2 ml.; 30 min. at 37°.
(3) Same as (2) + 33 micromoles γ-glutamylglycine; 30 min. at 37°.

adenosine triphosphate[12], this synthesis consisting in the addition of glycine to γ-glutamylcysteine which is formed first[13]. Whether the synthesis of glutathione by an exchange reaction indicates an alternate pathway or the last step of the synthesis of the tripeptide with the participation of adenosine triphosphate may be decided by study of the respective enzyme preparations.

The experiments show that the transfer of the glutamyl radical is not a property of glutathione alone, but also of other γ-glutamyl peptides (cf. ref. 2*b*). The question arises whether the presence of free γ-glutamyl peptides other than glutathione has escaped discovery because of the lack of an easily detectable functional group or because of their rapid metabolic utilization. It can be visualized that the substitution of an amino-acid in its α-amino-group by a γ-glutamyl radical modifies the properties of the amino-acid in such a way that it may either undergo further synthetic reactions by enzymically catalysed exchange, or is enabled to condense its free α-carboxyl group with the amino-group of another amino-acid with participation of adenosine triphosphate (cf. ref. 14).

This work has been carried out in part under grants from the Rockefeller and the National Vitamin Foundations, and under a contract between the Office of Naval Research and the New York State Psychiatric Institute.

P. J. Fodor
A. Miller
H. Waelsch

New York State Psychiatric Institute,
and Department of Biochemistry,
College of Physicians and Surgeons,
Columbia University, New York.
May 11.

[1] Binkley, F., and Olson, C. K., *J. Biol. Chem.*, **188**, 451 (1951).
[2] Hanes, C. S., Hird, F. R. J., and Isherwood, F. A., (*a*) *Nature*, **167**, 818 (1951); (*b*) *Biochem. J.*, **51**, 25 (1952).
[3] Schou, M., Grossowicz, N., and Waelsch, H., *J. Biol. Chem.*, **192**, 187 (1951).
[4] Binkley, F., and Christensen, S. M., *Fed. Proc.*, **11**, No. 1, 188 (1952).
[5] Waelsch, H., Fodor, P. J., and Miller, A., *Fed. Proc.*, **11**, No. 1, 304 (1952).
[6] Waelsch, H., Borek, E., and Grossowicz, N., Abstracts, Amer. Chem. Soc., 116th Meeting, Atlantic City, 549 (1949).
[7] Grossowicz, N., Wainfan, E., Borek, E., and Waelsch, H., *J. Biol. Chem.*, **187**, 111 (1950).
[8] Stumpf, P. K., and Loomis, W. D., *Arch. Biochem.*, **25**, 2 (1950).
[9] Schou, M., Grossowicz, N., Lajtha, A., and Waelsch, H., *Nature*, **167**, 818 (1951).
[10] Morton, R. K., *Nature*, **166**, 1092 (1950).
[11] Racker, E., *J. Biol. Chem.*, **190**, 685 (1951).
[12] Johnston, R. P., and Bloch, K., *J. Biol. Chem.*, **188**, 221 (1951).
[13] Yanari, S., Snoke, J., and Bloch, K., *Fed. Proc.*, **11**, No. 1, 315 (1952).
[14] Waelsch, H., "Advances in Enzymology", **13** (1952).

Essential Role of Thiol Groups in Carboxylase

Essential thiol groups of enzymes are usually detected by the inactivation of the enzyme with sulphydryl reagents, such as substances forming mercaptide, or oxidizing or alkylating substances[1]. Yeast carboxylase seems to be affected in a rather uneven and contradictory way by sulphydryl group detectors since 4-aminophenyldichloroarsine[2], *p*-chloromercuribenzoate[3], iodine[3], iodoacetate[3], cupric[3,4], mercuric and silver ions[4], or quinone[5] inhibit the enzyme, while in other experiments, lewisite oxide[6], ethylarsenoxide[7], iodoacetate[4] or ethyl iodoacetate[8] do not modify its activity significantly. It must be pointed out: (*a*) that inhibition by a single thiol reagent does not prove the existence of sulphydryls, since even very selective mercurial compounds[9] can inactivate enzymes which by other evidence do not seem to contain essential thiol groups; and (*b*) that the effect of sulphydryl detectors often depends on the purity of the enzyme preparation tested[10], a circumstance neglected in some of the work quoted. Therefore, considering the essential part played by thiol groups in most of the enzymes related to pyruvate metabolism[2], it seemed interesting to make a systematic study of the action of several types of thiol reagents on a conveniently purified carboxylase, and for that purpose we have used the preparation described by Green *et al.*[4] (Q_{CO_2} about 12,000).

The activity of carboxylase dissolved in 0·05 *M* phosphate buffer *p*H 6·0 at 30°, measured manometrically, diminishes by 50 per cent after 15 min. incubation with any of the following inhibitors: 5·0 m*M* methylarsenoxide; 0·8 m*M* mapharside (3-amino-4-hydroxyphenylarsenoxide hydrochloride); 1·4 μ*M* *p*-chloromercuribenzoate; 1·4 μ*M* mercury (Hg^{++}); 2·5 μ*M* silver (Ag^{+}); 0·44 m*M* copper (Cu^{++}); 2·0 m*M* iodoacetate; 9·7 m*M* ethyl iodoacetate; 1·4 m*M* bromobenzylcyanide; greater than 10·6 m*M* chloroacetophenone (highest concentration obtained); 12·5 m*M* alloxane and 1·0 m*M* *o*-iodosobenzoate. Lachrymators, like ethyl iodoacetate and chloroacetophenone, affect the activity of carboxylase less than pyruvate oxidative decarboxylation by living cells of *Saccharomyces cerevisiæ*[11], and they are the slowest reacting of all the inhibitors tested. The effect of the arsenicals is not reversed by dilution and does not depend on the amount of carboxylase present, while inhibition by heavy metals (and *p*-chloromercuribenzoate) is not reversed by dilution, but depends on the enzyme concentration and may be described as pseudo-irreversible, following the definition of Ackermann and Potter[12].

Cysteine, glutathione or 2 : 3-dimercaptopropanol (*BAL*) can modify the inhibition of carboxylase by thiol reagents. Thiols protect carboxylase from inactivation by methylarsenoxide and mapharside, 2 : 3-dimercaptopropanol being more effective than cysteine or glutathione against methylarsenoxide; as regards mapharside, however, cysteine is more effective than 2 : 3-dimercaptopropanol. After inhibition with the arsenicals, carboxylase can be activated with thiols. 2 : 3-Dimercaptopropanol reduces significantly methylarsenoxide or mapharside inhibition (91·0 and 45·0 per cent, respectively), while an amount of cysteine or glutathione containing an equivalent amount of sulphydryl (As : SH ratio of 1 : 15 mol.) only diminishes the effect of methylarsenoxide to a smaller degree (40·0 per cent). The toxicity of

EFFECT OF CONCENTRATION OF PYRUVATE ON THE INACTIVATION OF CARBOXYLASE BY THIOL REAGENTS

0·2 ml. carboxylase solution (45·0 μgm. purified protein) was mixed with the inhibitor in the presence of pyruvate and 0·05 *M* phosphate buffer, *p*H 6·0. Total volume of fluid, 1·0 ml. Temp., 30°. Carboxylase activity measured manometrically

1·4 m*M* mapharside		3·3 μ*M* *p*-chloromercuribenzoate		10·0 m*M* sodium iodoacetate		1·0 m*M* *o*-iodosobenzoate	
Pyruvate conc. (m*M*)	Carboxylase inactivation (%)	Pyruvate conc. (m*M*)	Carboxylase inactivation (%)	Pyruvate conc. (m*M*)	Carboxylase inactivation (%)	Pyruvate conc. (m*M*)	Carboxylase inactivation (%)
None*	57·0	None*	88·0	None*	75·2	None*	47·5
10·0	27·2	—	—	10·0	54·0	19·0	33·0
24·8	21·2	25·0	71·0	25·0	42·1	32·0	19·3
40·0	13·0	51·5	58·7	50·0	39·6	64·0	16·1
103·0	6·6	108·5	33·8	100·0	27·6	160·0	5·7
330·0	0·0	217·0	24·5	200·0	7·2	320·0	5·0

* Carboxylase was mixed with the inhibitor and incubated at 30° for 15 min. before adding 0·1 ml. *M* pyruvate

heavy metals is prevented and almost completely reversed by thiols. 2 : 3-Dimercaptopropanol is more effective than cysteine against cupric or mercuric ions, but their action is similar against *p* chloromercuribenzoate or silver (Ag^+). Cysteine completely prevents carboxylase inactivation by iodoacetate or ethyl iodoacetate, provides partial protection against chloroacetophenone or bromobenzylcyanide, but does not affect the toxicity of the alkylating agents once they have reacted with the enzyme.

The reversal of the inhibition induced by *p*-chloromercuribenzoate or mercuric ion with cysteine or glutathione enables one to show that both inhibitors, the arsenical compounds *o*-iodosobenzoate and iodoacetate, react with the same group of carboxylase. If the enzyme inhibited by mercuric ions or *p*-chloromercuribenzoate is treated with mapharside, iodoacetate or *o*-iodosobenzoate, it can be activated by adding an amount of cysteine or glutathione unable to reverse the inactivation produced by the same concentration of marpharside, iodoacetate or *o*-iodosobenzoate alone.

The action of arsenicals, *p*-chloromercuribenzoate, mercuric ions, cupric ions, iodoacetate or *o*-iodosobenzoate, is greatly diminished or even nullified when they are added to carboxylase in the presence of pyruvate. The effect of pyruvate is proportional to its concentration, as shown in the accompanying table ; and it cannot be replaced by other electrolytes like sodium acetate or chloride. Pyruvate protection against *p*-chloromercuribenzoate or mercuric ions satisfies the equations of competitive inhibition[13], but only for each concentration of inhibitor. Pyruvate interferes with the combination of carboxylase with the inhibitor but does not dissociate the inactive complex, since once the enzyme has reacted with the inhibitor, the addition of any amount of substrate does not reduce the inhibition. Cocarboxylase and/or magnesium do not affect the action of mapharside, heavy metals or iodoacetate.

From this briefly summarized evidence, it may be concluded that the activity of carboxylase depends on thiol groups closely related to the formation of the carboxylase – pyruvate complex, which are extremely sensitive to heavy metals and their compounds, but less reactive to other thiol detectors like trivalent arsenical compounds, alkylating or oxidizing agents. These thiols do not give the Hefter's nitroprusside test and therefore must be considered sluggish reacting groups. Full experimental details of this work will be given elsewhere.

We are indebted to Boots Pure Drug Co., Ltd. (England), and the British Council ; Parke Davis and Co. (U.S.A.) ; and E. R. Squibb and Sons (Argentine) S.A., for kindly supplying samples of pure 2 : 3-dimercaptopropanol, mapharside and 3-amino-4-hydroxyphenyldichloroarsine, respectively.

A. O. M. STOPPANI
A. S. ACTIS
J. O. DEFERRARI
E. L. GONZALEZ

Department of Biochemistry,
School of Medicine,
University of Buenos Aires.
June 30.

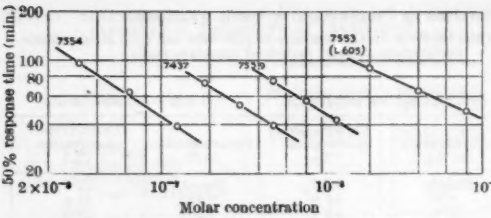
[1] Barron, E. S. G., "Advances in Enzymology", **11**, 201 (1951).
[2] Barron, E. S. G., and Singer, T. P., *J. Biol. Chem.*, **157**, 221 (1945).
[3] Meyer, J., quoted by Barron and Singer.
[4] Green, D. E., Herbert, D., and Subrahmanyan, V., *J. Biol. Chem.*, **138**, 327 (1941).
[5] Kuhn, R., and Beinert, H., *Ber.*, B, **76**, 904 (1943).
[6] Barron, E. S. G., Miller, Z. B., Bartlett, G. R., Meyer, J., and Singer, T. P., *Biochem. J.*, **41**, 69 (1947).
[7] Peters, R. A., Sinclair, H. M., and Thompson, R. H. S., *Biochem. J.*, **40**, 516 (1946).
[8] Mackworth, J. F., Rep. to Min. Supply, by Dixon, No. 4, quoted in Biochemical Society Symposia No. 2, 40 (Camb. Univ. Press, 1948) ; and *Biochem. J.*, **42**, 82 (1948).
[9] Kreke, C. W., Schaefer, M. A., Seibert, M. A., and Cook, E. S., *J. Biol. Chem.*, **185**, 469 (1950).
[10] Hopkins, F. G., and Morgan, E. J., *Biochem. J.*, **32**, 611 (1938).
[11] Stoppani, A. O. M., *Nature*, **167**, 653 (1951).
[12] Ackermann, W. W., and Potter, V. R., *Proc. Soc. Exp. Biol. Med.*, **72**, 1 (1949).
[13] Hunter, A., and Downs, C. E., *J. Biol. Chem.*, **157**, 427 (1945).

A New Method for the Bioassay of Cholinesterase Inhibitors

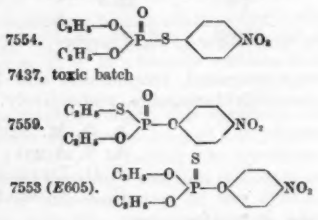
RECENT studies of the toxicity of anticholinesterase compounds have emphasized the need for a sensitive and reliable method for the biological assessment of their relative activities. We have developed such a bioassay procedure using the freshwater shrimp, *Gammarus pulex* deG.

The choice of such an aquatic organism was based on the following considerations : (*a*) the aqueous medium provides a uniform environment and allows of accurate administration of toxic agent ; (*b*) circulation of water through a gill system is likely to facilitate absorption ; (*c*) the presence of a highly organized nervous system is necessary for the development of a well-defined and characteristic response ; (*d*) ready availability, enabling sufficient numbers to be used for statistical significance ; (*e*) robustness and sufficient size to be handled and observed easily.

Investigation of a wide range of candidate organisms led to the selection of *Gammarus pulex* as the most satisfactory. Since an adequate supply of this species is available from local streams, we have not found it necessary to undertake large-scale breeding. Considerable numbers may be kept in shallow trays,



Comparative activity of 'standard Parathion' (*E*605) with its sulphur isomers and 'toxic batch':



containing not more than one centimetre depth of hard water, for at least a week without deterioration.

A complete test involves the observation of three or more groups of about forty gammarids, each in different dilutions of the toxic agent contained in large Petri dishes and maintained at 21·5° C. For convenience, observations are made at logarithmically separated intervals, and those specimens exhibiting the characteristic response are counted and removed.

The anticholinesterase substances used all produce similar effects, which may be divided into the following phases: (1) an initial phase in which responses appear normal; (2) a phase in which movements, though co-ordinated, are exaggerated; (3) a phase in which the exaggerated movements become incoordinated, with characteristic convulsions terminating in dorsal flexure where the concentration of toxic substance is high. This third phase is taken as the response and is followed by: (4) immobility except for the swimmerets and occasional spasmodic leg movements; (5) complete immobility and death.

The 50 per cent reaction-time for each concentration is obtained graphically from a log-normal transformation in which the probit corresponding to the percentage of organisms which have reacted is plotted against the logarithm of the corresponding time interval. This relationship is linear over the significant range between 10 and 90 per cent. When the 50 per cent reaction-time is plotted against concentration on logarithmic co-ordinates, a straight line is obtained, the slope of which is very similar for related compounds (see graph) and which is linear over a very wide range of concentrations.

An interesting application of the method is illustrated in the graph. It was found that certain batches of commercial 'parathion' (consisting mainly of O.O.diethyl O.*p*-nitro phenyl thiophosphate) were several times more toxic to mammals than a standard preparation. Isomerization was suspected, and the two sulphur isomers (O.S.diethyl O.*p*-nitrophenyl phosphate and O.O.diethyl S.*p*-nitrophenyl phosphate) were prepared by the manufacturers and submitted for examination.

The results obtained with the standard 'parathion' (7553), the suspect sample (7437) and the two isomers (7554) and (7559) are shown in the graph. The relative toxicities may be determined from the horizontal separation of the lines, and from these it was possible to confirm that sample (7437), which had a correct 'element' analysis, contained a high proportion of the more toxic isomers.

The systemic insecticide, OMPA (octamethyl pyrophosphoramide), has no action upon *Gammarus*. Dubois *et al.*[2] have shown that it does not inhibit cholinesterase *in vitro*, but is changed to an effective inhibitor by certain plant and animal tissues. Several workers[3] indicate that, in contrast to its sulphur isomers, pure O.O.diethyl O.*p*-nitrophenyl thiophosphate is also a poor inhibitor *in vitro*, but is transformed *in vivo* to an effective inhibitor. This compound, however, is toxic to gammarids.

This bioassay method was first demonstrated at a meeting of the British Pharmacological Society on July 9, 1949. It has been in continuous use for three years and has amply proved its reliability and precision.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication. A fuller account of the work will be published elsewhere.

S. Callaway
P. Dirnhuber
K. M. Wilson
Chemical Defence Experimental Establishment,
Porton, Wilts.
April 10.

[1] Grob, D., *Bull. Johns Hopkins Hosp.*, **87**, 95 (1950).
[2] Dubois, K. P., Doull, J., and Coon, J. M., *J. Pharmacol. and Exp. Therap.*, **99**, 376 (1950).
[3] Diggle, W. M., and Gage, J. C., *Biochem. J.*, **49**, 491 (1951); *Nature*, **168**, 998 (1951). Aldridge, W. N., and Barnes, J. M., *Nature*, **169**, 345 (1952); *Biochem. J.* (in the press).

Pyrolysis of Dissolved Nitrocellulose

The course of the thermal breakdown of the nitrocellulose molecule is not well understood. Previous studies of the chemical kinetics of the reaction have been carried out on the solid, and so have been hampered by the need to pyrolyse at low temperatures to reduce self-heating; and it is not certain how far the kinetics of gas evolution are complicated by reactions of the primary products, which probably include nitrogen peroxide. Further, the value of 46·7 kcal./mole recently found for the activation energy of the primary step by Wilfong, Penner and Daniels[1] is difficult to understand in the light of Phillips's demonstration[2] that the typical value for organic nitrates is 36–40 kcal.

A fresh experimental approach to the problem is suggested by Robertson's work on the pyrolysis of solutions of pentaerythritol tetranitrate[3] and cyclotrimethylenetrinitramine[4]. If nitrocellulose also could be studied in dilute solution, the difficulties we have mentioned would be much reduced. We have, in fact, found three solvents for nitrocellulose permitting such a study to be made, which have in sufficient degree the necessary qualities of chemical inertness towards nitrocellulose, low vapour pressure, and low melting point. They are 1-chloro-2 : 4-dinitrobenzene, benzophenone and 1-nitronaphthalene.

A preliminary study of the pyrolysis of nitrocellulose in these solvents between 165° C. and 200° C. has been made by following the evolution of gas, usually from 1 gm. of a 1 per cent solution of the *HX* 30/50 grade of nitrocellulose (11·85 per cent nitrogen). The usual assumption that the reaction is of the first order has proved to be approximately true; but there are certain deviations from the first-

order law, as is not surprising in a reactant of this complexity. Thus, during the first one-third of the reaction in 1-chloro-2 : 4-dinitrobenzene, the rate of evolution of gas shows only a slight fall, corresponding to a gradual increase of about 25 per cent in the rate constant; whereas during the last quarter, the rate constant falls to about 60 per cent of its value at the intermediate stage. If one specifies the rate of the reaction, perhaps rather arbitrarily, by the velocity constant prevailing over the middle of its course, one finds that the rates at 175° C. in the three solvents show a spread of only 20 per cent, a sufficiently close agreement to suggest that the solvents are inert towards nitrocellulose.

In 1-chloro-2 : 4-dinitrobenzene, the rates at six temperatures between 165° C. and 200° C. lead to the following equation for the velocity constant :

$$k(\text{sec.}^{-1}) = 10^{18\cdot0} \exp(-43\cdot0 \times 10^3/RT).$$

The average deviation, without regard to sign, between the observed rates and those calculated from this equation is 7 per cent. It is unlikely that this preliminary value of 43·0 kcal. for the activation energy is in error by more than 2 kcal. It is therefore doubtful whether nitrocellulose is behaving as a normal nitrate when judged by Phillips's criterion of the activation energy. The reason for the high value of $10^{18\cdot0}$ for the B factor is not certain, but even higher values have been recorded before, and Wilfong, Penner and Daniells probably seriously under-estimate the rate of decomposition in this temperature-region when they assume in effect that B has its 'normal' value of 10^{13}.

In 1-chloro-2 : 4-dinitrobenzene and benzophenone solutions, about five molecules of gas come from each sub-molecule of nitrocellulose. This yield of gas seems at first sight small; but it has been observed before[5] that much, perhaps one-half, of the products of pyrolysis of nitrocellulose is involatile. From 1-nitronaphthalene solutions, however, the yield is only 3·5 molecules per sub-molecule. Here the solvent presumably absorbs some of the products, but this need not invalidate the rates measured for its solutions. The reaction products have not been analysed.

R. D. Smith

Research Department,
Nobel Division,
Imperial Chemical Industries, Ltd.,
Stevenston, Ayrshire.
May 14.

[1] Wilfong, R. E., Penner, S. S., and Daniells, F., *J. Phys. Coll. Chem.* **54**, 863 (1950).
[2] Phillips, L., *Nature*, **160**, 753 (1947).
[3] Robertson, A. J. B., *J. Soc. Chem. Indust.*, **67**, 221 (1948).
[4] Robertson, A. J. B., *Trans. Farad. Soc.*, **45**, 85 (1949).
[5] Desmaroux, J., *Mem. des Poudres*, **29**, 189 (1939).

Paper Chromatographic Separation of Barbituric Acids

The barbituric acid derivatives have a characteristic absorption spectrum in the ultra-violet, and this is the basis of the most reliable methods for their quantitative determination. Small changes of the wave-length at which maximal absorption is found and changes in the absorption curve with varying *p*H usually are considered to be the means by which the different members of the group can be identified. But these methods have been found troublesome and unreliable. However, as the strength of absorption differs quite appreciably from one member to another, the identification of the derivative is necessary for a quantitative determination.

It seemed theoretically that paper chromatography might be a method for separation and identification, but a difficulty was the lack of any means of detection of the spots. Several colour reactions found in the literature were tried, but were not found reliable. It was clear that a new method had to be worked out, and the following procedure was found to give good results with most derivatives tested.

After development, the dried paper is sprayed with $N/2$ sodium hydroxide, and dried again. It is then brought in firm contact with a fluorescent screen and placed in front of an ultra-violet lamp, the paper facing the light. A low-pressure mercury lamp with a suitable filter letting through a fairly monochromatic light of about 2537 A. and a screen which fluoresces in this light have been used. The acids are seen as dark spots on the fluorescent screen. The method proved to be very sensitive.

As the absorption of the barbiturates is highest at a *p*H between 9 and 10, the spraying of the paper with an alkaline solution is very important. The resultant alkalinity of the paper is not known, and experiments are in progress to investigate which alkaline solution is to be preferred.

This arrangement of a screen which fluoresces with ultra-violet light seems to be a sensitive method for the detection of all kinds of substances absorbing ultra-violet light, and probably it has wide applications. Permanent records can, of course, be made in the usual way, by taking photographic contact prints of the sprayed and dried paper. It is, however, more convenient to draw pencil marks around the spots on the paper. After copying the drawing, the spots can be extracted if desired. By using this method it was found that the different barbituric acids could be separated by paper chromatography.

We are continuing to investigate this method and a full account will appear in the near future.

Arne Grieg

Central Clinical Laboratory,
St. Erik's Hospital,
Stockholm.
June 12.

Specificity of Vitamin B_{12} for *Euglena*

In an earlier publication[1] we reported that vitamin B_{12} could not be replaced for *Euglena gracilis* var. *bacillaris* by vitamin-free casein hydrolysate, carbon-treated peptone, methionine, ascorbic acid, pteroylglutamic acid, a variety of purine and pyrimidine bases or by xanthopterin and a number of related compounds. Hutner *et al.*[2] found thymidine to be ineffective. Vitamin B_{12a} (hydroxocobalamin) was active[1]. We have examined a number of additional compounds for vitamin B_{12} activity on *Euglena*.

Emerson *et al.*[3] reported the vitamin B_{12}-like activity of α- and β-ribazole and some related compounds. Samples of these compounds were obtained through the courtesy of Dr. Karl Folkers and tested on *Euglena* in our liquid medium I [1,4]. At 0·166 mgm. per ml., α- and β-ribazole had an activity on *Euglena* equivalent to 1–3·4 μμgm. of vitamin B_{12} per ml. At 0·00166 mgm. and 0·0000166 mgm. per ml. no effect was observed. For *Euglena*, vitamin B_{12} was from 50,000,000 to 150,000,000 times as active as

α- or β-ribazole; for rats, Emerson *et al.* found vitamin B_{12} to be 400 times as active as the ribazoles. At 0·166 mgm. per ml., 1-D-ribityl-5,6-dimethylbenzimidazole and 5,6-dimethylbenzimidazole were inactive on *Euglena* in our experiments. Emerson *et al.* found vitamin B_{12} to have from 8,000 to 20,000 times the activity of the two benzimidazoles on rats. Although the results with *Euglena* agree with those on rats, in that the α- and β-ribazoles were more active than the two benzimidazoles, all the compounds were much less effective than on the rat.

Woolley[5] found that 1,2-dimethyl-4,5-diaminobenzene increased the synthesis of vitamin B_{12} by *Bacillus megatherium*, whereas 1,2-dichloro-4,5-diaminobenzene reduced its synthesis and in sufficient amounts inhibited growth. He suggested that the former compound might be a precursor for vitamin B_{12} and the latter an antagonizer of the precursor. Dr. Woolley generously supplied us with some of each of the above compounds. At 0·5 mgm. per ml. in our liquid medium I, the dichloro compound had little or no effect on the growth of *Euglena* in the presence of 0·00002 μgm. of vitamin B_{12} per ml. Woolley found 0·1 mgm. per ml. under his conditions reduced growth of *Euglena* by 50 per cent. In our experiments the dimethyl compound at 0·1 μgm. per ml. in the absence of vitamin B_{12} had no effect on the growth of *Euglena*. Since *Euglena* responds under our conditions to 1 μμgm. of vitamin B_{12} per ml., the dimethyl compound had less than 1/100,000 the effect of vitamin B_{12}. Woolley reported 1,2-dimethyl-4,5-diaminobenzene to be between 1/500,000 and 1/1,000,000 as effective as vitamin B_{12} for *Euglena gracilis*.

Through the courtesy of Dr. T. H. Jukes, a sample of ammonia cobalichrome was obtained from Dr. V. Petrow (his *AC2*). This compound is vitamin B_{12} with ammonia substituted for cyanide. We were advised that the substance was unstable and could not be heated for long periods in the light. We sterilized a solution of the compound by filtration and pasteurized an aliquot by bringing it to a quick boil. With both methods the substance was added to our liquid medium I after the latter had been sterilized, and the cultures were incubated in the dark at 25° C. Both the filtered and pasteurized samples of the ammonia cobalichrome had about one-half the activity of vitamin B_{12}. According to Cooley *et al.*[6], ammonia cobalichrome has 2·5 times the activity of vitamin B_{12} for *Lactobacillus lactis*, 1·5 times its activity for *Escherichia coli* and equal activity for the chick.

Pfiffner *et al.*[7] reported the isolation of an organism from bovine rumen which under anaerobic conditions produced a mixture of cobalt-containing pigments belonging to the vitamin B_{12} group. Two major constituents were obtained in crystalline form. They had the same order of activity on *L. leichmannii* and *L. lactis* Dorner as vitamin B_{12} but were inactive on chick growth and rat anti-hæmorrhagic kidney tests. Dr. Pfiffner kindly supplied us with samples of crystalline pseudovitamin B_{12}[8], crystalline pseudovitamin B_{12}[9] and cyano-pigment *C*. Pseudovitamin B_{12} is about as active on *L. leichmannii* and *L. lactis* as vitamin B_{12}; pseudovitamin B_{12} has about half the activity of B_{12} on *L. leichmannii*, *L. acidophilus* and *L. lactis* Dorner, and cyano-pigment *C* has only a trace of activity on *L. leichmannii*[9]. Pseudovitamin B_{12} and pseudovitamin B_{12}[9] had the same order of activity on *Euglena* as vitamin B_{12}. The activity of cyano-pigment *C* was about half that of vitamin B_{12}.

Dr. C. A. Elvehjem furnished us with a preparation of a substance containing cobalt[10] which was isolated from rat fæces. The material was active on *L. leichmannii* and the chick, but had little or no activity for the rat. In our hands this material had about twice the activity for *E. gracilis* as reported for *L. leichmannii*.

Although vitamin B_{12} has a high degree of specificity for *Euglena gracilis* var. *bacillaris*, our results demonstrate that substances exist in Nature which have vitamin B_{12} activity for *Euglena* and little or none for animals. Assays for vitamin B_{12} made with *Euglena* are not sure indications of the presence of the vitamin.

This investigation was supported in part by the Lucy Benjamin Rogers Fund and the Howard Bayne Research Fund of the New York Botanical Garden.

William J. Robbins
Annette Hervey
Mary E. Stebbins

Department of Botany,
Columbia University,
and
The New York Botanical Garden.

May 6.

[1] Robbins, W. J., Hervey, A., and Stebbins, M. E., *Bull. Torrey Bot. Club*, **77**, 423 (1950).
[2] Hutner, S. H., Provasoli, L., Stokstad, E. L. R., Hoffmann, C. E., Belt, M., Franklin, A. L., and Jukes, T. H., *Proc. Soc. Exp. Biol. and Med.*, **70**, 118 (1949).
[3] Emerson, G., Holly, F. W., Shunk, C. H., Brink, N. G., and Folkers, K., *J. Amer. Chem. Soc.*, **73**, 1069 (1951).
[4] Robbins, W. J., Hervey, A., and Stebbins, M. E., *Bull. Torrey Bot. Club*, **78**, 363 (1951).
[5] Woolley, D. W., *Proc. Soc. Exp. Biol. and Med.*, **75**, 745 (1950); *J. Exp. Med.*, **93**, 13 (1951).
[6] Cooley, G., Ellis, B., Petrow, V., Beaven, G. H., Holiday, E. R., and Johnson E. A., *J. Pharm. and Pharmacol.*, **3**, 271 (1951).
[7] Pfiffner, J. J., Calkins, D. G. Peterson, R. C., Bird, O. D., McGlohon, V., and Stipek, R. W., *Amer. Chem. Soc.*, Abstracts of 120th Meeting 1951, 22*C* (1951).
[8] Dion, H. W., Calkins, D. G., and Pfiffner, J. J., *J. Amer. Chem. Soc.* **74**, 1108 (1952).
[9] From correspondence with Dr. J. J. Pfiffner.
[10] Lewis, U. J., Tappan, D. V., and Elvehjem, C. A., *J. Biol. Chem.*, **194**, 539 (1952).

Nucleic Acids of Rickettsiæ

Smith and Stoker[1] have noted that the deoxyribonucleic acid of *Q*-fever rickettsiæ (*R. burneti*) grown in embryonated eggs is closely similar in composition to that of chick embryos, the only significant difference being lack of 5-methyl cytosine from the former. To account for this similarity, they mention the possibility that rickettsiæ may incorporate nucleic acid directly from their host. This hypothesis could be tested, they point out, by analysis of the same organism grown in a different host.

We have recently analysed the deoxyribonucleic acid of another rickettsia from the same host. Deoxyribonucleic acid was isolated[2] from epidemic typhus rickettsiæ (*R. prowazeki*) grown in chick yolk-sac endothelium, and the purine and pyrimidine bases estimated[3] after hydrolysis in perchloric acid (70 per cent, 1 hr. at 100° C.). The estimated bases were equivalent to 96 per cent of the deoxyribonucleic acid phosphorus. No methyl cytosine could be detected. The ratios of the bases found (mean of two analyses), along with those reported for *R. burneti*, are as follows:

	Moles per cent			
	Adenine	Thymine	Guanine	Cytosine
R. burneti (ref. 1)	29·5	26·0	22·5	22·0
R. prowazeki	35·7	31·8	17·1	15·4

The deoxyribonucleic acid of *R. prowazeki* clearly differs in composition from those of *R. burneti* and of the host chick embryos. In the *E. coli*-phage system, the deoxyribonucleic acids of host and virus differ markedly[4], and it has been concluded from tracer studies[5] that host nucleic acid is utilized by the parasite only in the form of breakdown products. It is likely that any host nucleic acid used in synthesis of rickettsiæ would also be first extensively degraded.

A common pattern in the composition of deoxyribonucleic acid, first pointed out by Chargaff[6], has apparently wide validity. The molar ratios (adenine) : (thymine), and (guanine) : (cytosine (plus methyl cytosine when present)) have nearly constant values close to unity, whereas the ratio (adenine + thymine) : (guanine + cytosine) is characteristic of the source of the nucleic acid. The rickettsiæ are no exception :

	A : T	G : C	(A + T) : (G + C)
R. burneti	1·13	1·02	1·25
R. prowazeki	1·12	1·11	2·08

If, for as yet obscure reasons, nearly constant ratios of adenine to thymine and guanine to cytosine are the rule in deoxyribonucleic acids, this would greatly increase the probability of two distinct deoxyribonucleic acids having like composition by chance. This may account for the similarity of the *R. burneti* and chick nucleic acids.

G. R. Wyatt

Laboratory of Insect Pathology,
Sault Ste. Marie,
Ontario.

S. S. Cohen

Department of Pediatrics,
Children's Hospital of Philadelphia,
and the
Department of Physiological Chemistry,
University of Pennsylvania,
Philadelphia.

April 25.

[1] Smith, J. D., and Stoker, M. G. P., *Brit. J. Exp. Path.*, **32**, 433 (1951).
[2] Cohen, S. S., *J. Immunol.*, **65**, 475 (1950).
[3] Wyatt, G. R., *Biochem. J.*, **48**, 584 (1951).
[4] Smith, J. D., and Wyatt, G. R., *Biochem. J.*, **49**, 144 (1951).
[5] Weed, L. L., and Cohen, S. S., *J. Biol. Chem.*, **192**, 693 (1951). Kozloff, L. M., *J. Biol. Chem.*, **194**, 95 (1952).
[6] Chargaff, E., *Fed. Proc.*, **10**, 654 (1951).

Symbiosis in *Ptilinus pectinicornis* L.

It is well known from the work of Buchner[1], Breitsprecher[2], and others that mycetomes occur at the anterior end of the larval midgut of several species of Anobiid beetles. The mycetocytes are distended with micro-organisms which are of obscure taxonomy, but appear yeast-like, and of which the symbiotic role has been established by Koch's[3] demonstration of their necessary presence in *Sitodrepa panicea*, if the larva is to grow normally. Blewett and Fraenkel[4] have shown that the presence of the symbionts in *Sitodrepa* larvæ can offset a dietary deficiency of five vitamins of the B group : the symbionts in *Lasioderma serricorne* can apparently supply six of these vitamins to the larva.

The vitamins could become available to the larva either by excretion from the organisms, or by digestion of organisms expelled from the mycetocytes into the gut. The former view now gains support from the observation that, in the larva of *Ptilinus pectinicornis*, the mycetomes have migrated forward from the anterior end of the midgut to form a pair of lobed organs dorso-lateral to the front of the gizzard. Connexion with the midgut is retained through a pair of slender ducts, about 16 μ in external diameter, with walls about 4 μ in thickness, passing on either side of the gizzard. These organs are observable both in sections and in dissections. In sections, the mycetocytes can be seen to be packed with minute, round organisms, none of which has been observed in the ducts.

There is therefore strong morphological evidence for concluding that the symbionts in the larva of *P. pectinicornis* secrete a fluid which, by analogy with *Sitodrepa* and *Lasioderma*, should contain vitamins of the B group which the larva requires but is unable to obtain in sufficient quantities from the dead, dry wood in which it normally lives.

When the larva pupates, the mycetomes retain their identity but become a little reduced in size, while the ducts contract and thicken until the mycetomes are drawn back into close contact with the anterior end of the midgut. The mycetomes then look little different from those in the larvæ of several other species of Anobiids in which they appear as short diverticula from the midgut.

This note is published by permission of the Department of Scientific and Industrial Research.

E. A. Parkin*

Forest Products Research Laboratory,
Princes Risborough,
Aylesbury, Bucks.

April 29.

* Now at the Pest Infestation Laboratory, London Road, Slough, Bucks.

[1] Buchner, P., "Tier und Pflanze in Symbiose" (Borntraeger, Berlin, 1930).
[2] Breitsprecher, E., *Z. Morph. Ökol. Tiere*, **11**, 495 (1928).
[3] Koch, A., *Biol. Zbl.*, **53**, 199 (1933).
[4] Blewett, M., and Fraenkel, G., *Proc. Roy. Soc.*, B, **132**, 212 (1944).

Occurrence of Malonic Acid in Plants

The occurrence of malonic acid has been reported in the leaves of lucerne[1] and in green wheat plants[2]. This acid is well known as a competitive inhibitor of succinic dehydrogenase, and has been used extensively in investigations of the tricarboxylic acid cycle. In consideration of this inhibiting effect of the acid, some further investigations have been made into its presence in plants.

The organic acids present in water extracts of plant tissue have been identified and quantitatively estimated by paper partition chromatography. The acids were extracted from mature leaves by boiling about 6 gm. in water with 1 ml. normal sulphuric acid. The tissue was then ground in a mortar and a clear extract obtained by centrifuging; this was concentrated to 6 ml. before using on the chromatogram. The chromatograms were developed by a method similar to that of Lugg and Overell[3], using as solvent the water-poor phase of *tert.*-amyl alcohol (80 ml.) – chloroform (80 ml.) – water (80 ml.) – formic acid (30 ml.). The acids were detected by spraying with an aqueous solution of bromocresol green. The R_F value of malonic acid (0·59) is identical with that of tricarballylic acid and very close to that of maleic acid (0·60). Malonic acid was distinguished from the others by the use of two different sprays—ammoniacal silver nitrate and ceric ammonium nitrate as suggested by Buch *et al.*[4]. The organic acids separated satisfactorily in the presence of the other substances,

for example, amino-acids and sugars in the plant extracts. An acid was only identifiable with this technique when more than 15 μgm. were present on the chromatogram, therefore acids present in a concentration below 0·5 mgm./ml. of extract, that is, 0·5 mgm./gm. fresh weight of tissue, were not identified in this type of extract.

Mature leaves from twenty-seven species of Leguminosæ were examined. Citric and malic acids were present in all of them in concentrations of 1·0–4·0 mgm./gm. fresh weight. Malonic acid was present in concentrations of 0·5–2·0 mgm./gm. fresh weight in eighteen species taken from the genera *Medicago*, *Phaseolus*, *Vicia*, *Ononis*, *Astragalus*, *Trifolium*, *Lupinus*, *Anthyllis*, *Lotus*, *Melilotus*, *Colutea*, *Sophora*, *Thermopsis* and *Trigonella*. Malonic acid could not be identified in nine species taken from the genera *Lathyrus*, *Onobrichis*, *Vicia*, *Cercis*, *Mimosa*, *Piptanthus*, *Hedysarum*, *Cassia* and *Gleditschia*. Other species examined included members of the Umbelliferæ, Rosaceæ, Ranunculaceæ, Chenopodiaceæ and Crassulaceæ. Of these only the Umbelliferæ showed an accumulation of malonic acid comparable to that in the Leguminosæ; for example, the leaves of *Anthriscus* and *Apium* contained more than 1·0 mgm./gm. fresh weight. As well as the accumulation of malonic acid found frequently in these two families, it seems probable that it occurs in smaller concentrations elsewhere. For example, extracts of the leaves of *Helianthus annus* L., purified and concentrated by the use of ion-exchange resins, were found to contain citric and malic acids (1·0 mgm./gm. fresh weight) and much smaller quantities of malonic, lactic, succinic, aconitic and fumaric acids.

Confirmation of the identification of malonic acid in the leaves of runner bean, *Phaseolus coccineus* L., has been provided by isolation of the pure acid. A water extract of the leaves was purified and concentrated on ion-exchange resins. The acids were separated by paper chromatography, and citric, malic, malonic, lactic, succinic, aconitic and fumaric acids were identified. A chromatogram was run with a complete band of extract along the starting line; after separation the band of paper corresponding to malonic acid (calculated to contain 60 mgm.) was excised and the acid extracted from it with boiling water. On recovery from the water and recrystallization from ethyl acetate, 20 mgm. of crystals were obtained, m.p. 131–133° C. (m.p. malonic acid = 135° C.); there was no depression of the mixed melting point. The *p*-nitrobenzyl ester of the plant acid melted at 83·5–85° C. (m.p. malonic acid ester = 86° C.) and there was no depression of the mixed melting point.

Analysis of the stem tissue of runner bean gave in mgm./gm. fresh weight, citric acid = 0·7, malic acid = 1·1, malonic acid = 2·1 and succinic acid = 0·15. It is therefore necessary in investigations into the reactions of the tricarboxylic acid cycle in such tissues to take into consideration the presence of endogenous malonic acid. For example, the malonic acid forms a solution about 0·03 *M* in the expressed sap of runner bean stem, and it has been found that a solution as low as 0·02 *M* malonic acid, adjusted to *p*H 4·5 with caustic potash, inhibits by 50 per cent the oxygen uptake of disks of this tissue and causes accumulation of succinic acid. Further investigations into the acid metabolism of this tissue are being carried out and full details will be published later.

I wish to thank Prof. T. A. Bennet-Clark for his advice and encouragement during the course of this work and Mr. R. D. Mulley, of the Chemistry Department of King's College, for preparation of the ester of malonic acid.

L. E. Bentley
Department of Botany, King's College,
University of London.
Oct. 2.

[1] Turner, W. A., and Hartman, A. M., *J. Amer. Chem. Soc.*, **47**, 2044 (1925).
[2] Nelson, E. K., and Hasselbring, H., *J. Amer. Chem. Soc.*, **53**, 1040 (1931).
[3] Lugg, J. W. H., and Overell, B. T., *Aust. J. Sci. Res.*, A, 1, 98 (1948).
[4] Buch, M. L., Montgomery, R., and Porter, W. L., *Anal. Chem.*, **24**, 489 (1952).

Variation in Leaf Form in *Callitriche intermedia*

Callitriche intermedia shows a well-marked variation in its leaf form, dependent on whether the crown of the plant is submerged or floating at the surface of the water. When the crown is submerged, linear leaves are produced, up to 3 cm. in length and 1 mm. broad. When the crown reaches the surface, ovate leaves are produced, about 1·5 cm. long and 4 mm. broad at the widest point. A reversion to the linear type of leaf is produced if the crown is afterwards submerged.

In considering the mechanism involved in the change in leaf form, it is of interest to refer to the work of McCallum[1] on *Proserpinaca palustris*, where an essentially similar response of leaf form to emergence from the water was studied. McCallum was able to induce the aerial type of leaf by growing the plants in a nutrient solution of a concentration which just failed to plasmolyse the tissues. No compensation for evaporation from the nutrient solutions was made. The suggestion was advanced that the withdrawal of water from the tissues by osmosis created an effect similar to the withdrawal of water by transpiration on exposure to the air. Burns[2], in a criticism of McCallum's work, stated that the aerial type of leaf was produced in the spring and was formed even on submerged shoots at that season. Burns suggested that light was the determining factor in the production of the aerial leaf form.

I have applied a modification of McCallum's methods to *Callitriche intermedia*. Linear-leaved shoots were submerged in sea water diluted to 30 per cent of its original concentration (30 per cent sea water just fails to plasmolyse tissues of the linear leaves). In seventeen days (July) small, ovate leaves were visible at the crowns. These ovate leaves were preceded by transitional forms, the intermediate leaves having a more or less ovate proximal part and a linear distal part. The concentration of the diluted sea water was now about 37 per cent. Ovate-leaved shoots grown under the same conditions remained ovate-leaved. Linear-leaved shoots submerged in tap-water remained linear-leaved, while ovate-leaved shoots submerged in tap-water produced linear leaves.

The ovate leaves which are produced by immersion in diluted sea water have the general form of the normal ovate leaves but do not attain a length of more than 3 mm. The induced leaves resemble normal ovate leaves in the possession of numerous stomates and of isodiametric epidermal cells. Normal linear leaves have few or no stomates, and the epidermal cells are elongated in the direction of the length of the leaf. The induced ovate leaves, however, have a single vein as in the linear leaf, whereas the normal ovate leaf has three veins. An interesting

feature of the shoots bearing induced ovate leaves is the development of axillary buds (with ovate leaves) associated with the absence of elongation of the shoot after immersion in the diluted sea water.

These results are being considered in relation to a general study of heterophylly in *Callitriche intermedia*.

HERBERT JONES

Department of Botany,
University College of Wales,
Aberystwyth. July 22.

[1] McCallum, W. B., *Bot. Gaz.*, **34**, 93 (1902).
[2] Burns, G. P., *Ann. Bot.*, **18**, 579 (1904).

Lowered Liver Vitamin A Reserves in Avian Coccidiosis

DURING the course of a routine series of determinations of vitamin A reserves of poultry in health and disease it became evident that, in the case of fowls affected with coccidiosis, these reserves were almost invariably of a low order.

The range in a series of thirty-nine affected birds submitted for diagnosis from farms in different parts of England was 0–126 I.U. vitamin A/gm., with a mean value of 6·9 I.U./gm.

The birds in question were of varying ages and breeds and were from farms on which widely different systems of husbandry were practised. The infections included both the cæcal type (*Eimeria tenella*) and the intestinal type (*Eimeria necatrix*) of coccidiosis.

Observations were therefore extended to a series of ten Barred Rock and Brown Leghorn × Barred Rock fowls which were suffering from a natural infection of intestinal coccidiosis, and which were from a flock maintained at the Poultry Research Station of the Animal Health Trust, where they had been reared on range in fold units. The ages of the birds varied from 8 to 24 weeks, but in all cases the liver vitamin A reserves were again of low order, the range being 2–38 I.U./gm. with the mean of 20·8 I.U./gm. The food provided was a nutritionally balanced ration and was known to contain 2,100 μgm. carotene = 3,500 I.U. vitamin A/lb. in the form of dried grass meal. The livers of ten unaffected birds from the same flock were examined and found to have normal reserves within the range of 200–420 I.U./gm., with a mean value of 292 I.U./gm.

These findings would appear to be of special interest in view of the fact that the intestine is now recognized as the seat of conversion of carotene to vitamin A, in chicks as well as mammals[1]. It is suggested that invasion of the intestinal wall by the coccidia may have resulted in impaired conversion of carotene to vitamin A. Moreover, it has been shown that the provision of adequate amounts of cod liver oil accelerates recovery from coccidiosis[2], and this may be due to its vitamin A content.

These studies are now being extended to birds artificially infected with *Eimeria necatrix* and receiving vitamin A either as the vitamin A alcohol or as carotene.

I am grateful to Dr. Horton-Smith for his collaboration.

ALAN W. DAVIES

Poultry Research Station,
Animal Health Trust,
Houghton, Huntingdon. Oct. 7.

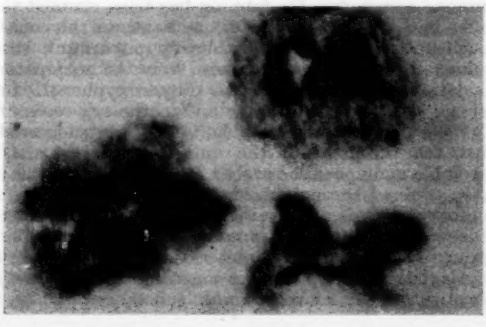
[1] Kon, S. K., and Thompson, S. Y., *Brit. J. Nutrit.*, **5**, 114 (1951).
[2] Murphy, R. R., Hunter, J. E., and Knandel, H. C., *Poult. Sci.*, **17**, 377 (1938).

Spread of Pigment in Sheep Skin Autografts

SEVERAL theories have been advanced to explain the spreading of melanin pigmentation in mammalian skin during post-natal life[1]. Billingham and Medawar[2] found support for their theory of 'infective' cellular transformation from skin grafting experiments with guinea pigs. It is well known that if black skin from an adult guinea pig is grafted on to a white area on the same animal, melanin pigment appears in the white skin surrounding the graft, though not in the hairs. A similar phenomenon was recently observed with grafts of cattle skin[3]. The spreading of pigment to surrounding hairs instead of to epidermis has been reported in homografts to new-born mice[4] and in autografts to new-born black hooded rats[1]; but, so far as we are aware, it has not been observed in the healthy skin of more mature mice or rats, nor in any species other than the above.

In the black skin of sheep, pigmented dendritic cells are present in the hair matrix of hair follicles and in varying concentrations in the root sheaths and the basal layer of the epidermis. Boyd[5] showed that dihydroxyphenylalanine-positive but unpigmented dendritic cells were present in the same locations in the white skin of spotted and recessive white breeds. The distribution of dendritic cells was the same in spotted guinea pigs[2], although in the latter the unpigmented dendritic cells were negative to dihydroxyphenylalanine.

In the course of skin autografting experiments on sheep, with techniques similar to those used by Billingham and Medawar[2] for rodents, fitted thin Thiersch grafts were made from a black skin patch on the thigh to the white skin of the thorax of a two-months old merino lamb. The grafts 'took' and the grafted skin produced a normal crop of wool fibres. The black pigmentation of epidermis and hairs persisted in the grafted skin. About fifteen days after the operation, pigment was observed spreading into the surrounding white recipient skin. At first the pigment was confined to the epidermis of the recipient skin, but after twenty-five days it was noted in a few wool fibres, and at forty days very many of the fibres on this marginal area were black. Further tests are required to determine whether the black fibres were derived solely from follicles which developed after pigment had spread to the epidermis. The accompanying photograph shows the shaved surface sixty days after the operation, with three grafts of black skin, each surrounded by a grey ring of recipient skin. In another experiment, grafting of skin from a black patch on the neck to the white skin of the thorax of an 8-months old ewe caused



spread of pigment into the recipient epidermis, but there was little or no pigmentation of recipient hairs.

These observations were confirmed by the histological study of skin samples taken at frequent intervals. In normally black skin, pigmented dendritic cells were found in the basal layer of the epidermis and in the outer root-sheath and hair matrix, and melanin granules were found in some epidermal cells and in the cortex of most hairs. This distribution of pigment persisted in black skin after it was grafted to a white area, and, after twenty to thirty days, pigmented dendritic cells appeared for the first time in the adjacent recipient area, first in the basal layer of the epidermis and later in a few follicles, in the hair matrix or the outer root sheath.

The behaviour of black-on-white skin autografts in the sheep was very similar to that in adult guinea pigs[2] and cattle[3]. In both guinea pigs and sheep, pigmented dendritic cells appeared in the surrounding host epidermis; in both, this might be due to the transformation of the white dendritic cells already present. Pigmentation of follicles and hairs in the host skin occurred to some extent in the sheep but not in the guinea pig or the cow. In all three species the spread of pigment began twenty to thirty days after the grafting operation and the rate was about 1 mm. per week for several weeks.

The sheep thus appears to be a useful subject for the study of the nature of pigment spreading. Further experiments are in progress and will be reported in detail elsewhere.

Margaret H. Hardy
A. S. Fraser
B. F. Short
Commonwealth Scientific and
Industrial Research Organization,
Division of Animal Health and Production,
Sydney,
and C.S.I.R.O. Section of Animal Genetics,
University of Sydney. April 2.

[1] Fawcett, M. E., *Physiol. Rev.*, **28**, 383 (1948).
[2] Billingham, R. E., and Medawar, P. B., *Heredity*, **2**, 29 (1948).
[3] Anderson, D., Billingham, R. E., Lampkin, G. H., and Medawar, P. B., *Heredity*, **5**, 379 (1951).
[4] Reed, S. C., *J. Exp. Zool.*, **79**, 337 (1938). Reed, S. C., and Henderson, J. M., *J. Exp. Zool.*, **85**, 409 (1940).
[5] Boyd, E., *Proc. Roy. Soc. Edin.*, **52**, 218 (1932).
[6] Billingham, R. E., and Medawar, P. B., *J. Exp. Biol.*, **28**, 385 (1951).

A Lipoprotein Precursor of Sclerotin in the Cockroach Cuticle

Recent work has shown that quinone tanning of protein structures is indeed of widespread occurrence in the invertebrates, as was suggested by Dennell[1]. The various tanned structures agree in showing a high degree of chemical stability, but the origin of the quinone responsible for tanning has been claimed to differ in different cases[2]. On one hand, in the cockroach ootheca[3] and in the blowfly puparium[4], the quinone has been shown to arise from the enzymatic oxidation of an alcohol-soluble dihydroxyphenol. In certain structures of *Mytilus* and in the egg cases of *Fasciola*[2], on the other hand, it has been suggested that the precursor of the quinone is an alcohol-insoluble amino-acid or protein in which tanning may have evolved through the oxidation of the phenolic hydroxyl groups of tyrosine without removal of the side-chains. A protein, 'prosclerotin', rich in phenolic groups has likewise been described in the cuticle of Myriapods[5], and it has been suggested that this may constitute a similar self-tanning substance.

In the present work, the process of hardening of the cockroach cuticle has been critically followed histochemically and by microchemical analysis, and two conclusions of importance emerge. First, the precursor of sclerotin, the impregnating material of the exocuticle, has been clearly shown to be a lipoprotein complex similar to that suggested by Wigglesworth[6] as constituting the cuticulin of the epicuticle. Secondly, the quinone responsible for the tanning of this precursor is derived from the oxidation of a dihydroxyphenol in the presence of a polyphenol oxidase at the surface of the cuticle. Hitherto, it has not been unequivocally shown that the hardening of the exoskeleton of a typical insect takes place in the same manner as in the special cases of the cockroach ootheca[3] and the blowfly puparium[4].

Sections of the fully hardened cuticle show that tanning involves only the outer zone of the soft pre-exuvial endocuticle of the sclerites, whereas the rest of the cuticle, as well as the whole of the arthrodial membranes, remains untanned. During preparation for hardening, a lipoid passes into the presumptive exocuticle, and is shortly followed by a protein rich in phenolic groups which comes to occupy the same region as the lipoid. The lipoid, shown by the Liebermann–Burchardt test to be a sterol, imparts a yellow coloration to the cuticle. The protein shows many of the properties of the 'prosclerotin' of Blower[5], except that it is restricted to the regions later to be tanned, whereas 'prosclerotin' is reported to be present throughout the thickness of the sclerite. Of the two constituents, lipoid and protein, only the latter reduces ammoniacal silver nitrate, and this only to a slight extent. It is likely that the stability shown by the exocuticle at this stage is due to the presence of the lipoid constituent. Just before the onset of darkening the lipoid loses its colour and ability to stain, possibly as a result of polymerization. A wave of quinone tanning demonstrable by a pronounced intensification of the argentaffin reaction then passes from the epicuticle inwards and stops sharply at the inner boundary of the lipoprotein complex.

That the inward spread of darkening is truly due to the passage into the cuticle of a dihydroxyphenol and its subsequent oxidation to an *o*-quinone, and is not the result of the presence of a self-tanning protein, is indicated by the results of micro-analysis, which show clearly the presence of dihydroxyphenols in the cuticle during the later stages of the process. Further than this, the blood at all stages of hardening darkens on exposure to air, indicating the presence in it of tyrosine and tyrosinase, and in the later stages there is evidence of the presence of a free phenol. Finally, the epicuticle of the sclerites, but not of the arthrodial membranes, contains a polyphenol oxidase readily demonstrable by the 'Nadi' reagent. These observations are in fundamental agreement with those of Dennell[4] on *Sarcophaga*.

It appears, then, that the substance tanned is a lipoprotein complex, and not the structural protein of the procuticle[4], nor a simple protein passed in preparatory to hardening[6]. Experiments on the artificial tanning of cuticles before the onset of the natural process indicate that not only does the quinone combine with the lipoprotein complex as in natural hardening, but also with the sterol alone at an earlier stage. It is suggested that it is such a sterol-protein complex, the precursor of sclerotin, that has been designated prosclerotin by Blower[5].

A lipoprotein complex may be of common occurrence in naturally tanned structures. In both the cockroach ootheca and in the blowfly puparium, I have clearly demonstrated a lipoid to be present throughout the whole thickness of the tanned regions. Furthermore, lipoids have been reported in the exocuticle of Myriapods[7]. It will be of interest to learn whether lipoids are associated with proteins in other tanned structures.

A full account of this and other aspects of the present work will be given elsewhere. My thanks are due to Prof. R. Dennell for his interest and criticism.

S. R. A. Malek

Department of Zoology,
University,
Manchester 13.
April 28.

[1] Dennell, R., *Nature*, **164**, 370 (1949).
[2] Brown, C. H., *Nature*, **165**, 275 (1950).
[3] Pryor, M. G. M., *Proc. Roy. Soc.*, B, **128**, 378 (1940).
[4] Dennell, R., *Proc. Roy. Soc.*, B, **134**, 79 (1947).
[5] Blower, G., *Nature*, **165**, 569 (1950).
[6] Wigglesworth, V. B., *Proc. Roy. Soc.*, B, **134**, 163 (1947).
[7] Blower, G., *Quart. J. Mic. Sci.*, **92**, 141 (1951).
[8] Pryor, M. G. M., *Proc. Roy. Soc.*, B, **128**, 393 (1940).

Packed Red-Cell Volume in the Tropics

It was found that when men stayed in air-conditioned rooms at about 30° C. for a few days their packed red-cell volume fell[1,2]. A rise in this value was likewise found in conditions of low environmental temperature[2]. More prolonged exposure to conditions of high environmental temperature caused by change of season was also associated with a fall in the packed red-cell volume[3]. No satisfactory information about the physiological effect on the packed red-cell volume of people living for several months or years in a warm climate could be found in the available literature. The results of an investigation made in Singapore may, therefore, be of interest.

The subjects were healthy, well-nourished men and women of different races (see table) who had lived in the tropics for at least six months, and they were all between twenty and forty years old. Samples of venous blood were collected with minimal stasis, and an ammonium and potassium oxalate mixture used as an anti-coagulant[4]. Estimations of the packed red-cell volume were made by means of Wintrobe hæmatocrit tubes[5] which were centrifuged for 1 hr. at 3,000 r.p.m.

Packed Red-Cell Volume of Normal Men and Women Living in Singapore

Racial group	No.	Mean (per cent)	S.D.	S.E. of mean
Men				
Chinese	73	47·69	6·513	0·7622
Indians and others	58	47·59	7·266	0·9541
European	121	47·02	5·420	0·4927
All males	252	47·35	4·508	0·2838
Women				
Europeans	57	40·56	6·060	0·8025
Asians	21	41·43	9·824	2·1440
All females	78	40·80	5·429	0·6146

The mean packed red-cell volume of 252 men was 47·35 per cent, and that of 78 women 40·80 per cent. Details are given in the table. The differences between the mean value for each racial group were not statistically significant by the *t* test[6].

The present findings are slightly higher than those found in temperate climates[7]. The results of this investigation suggest that living in a warm environment for several months or years is not associated with a fall in the packed red-cell volume. The fall in this value found in men during shorter conditions of exposure to heat[1–3] appears to have been a temporary change. Recovery of the packed red-cell volume might provide objective evidence of complete acclimatization.

G. R. Wadsworth

Department of Physiology,
University of Malaya,
Singapore 3.
May 12.

[1] Bazett, H. C., Sunderman, F. W., Doupe, J., and Scott, J. C., *Amer. J. Physiol.*, **129**, 69 (1940).
[2] Glaser, E. M., *J. Physiol.*, **110**, 330 (1949).
[3] Maxfield, M. E., Bazett, H. C., and Chambers, C. C., *Amer. J. Physiol.*, **133**, 128 (1941).
[4] Heller, V. G., and Paul, H., *J. Lab. Clin. Med.*, **19**, 777 (1933).
[5] Wintrobe, M. M., *J. Lab. Clin. Med.*, **15**, 287 (1929).
[6] Fisher, R. A., "Statistical Methods for Research Workers" (London: 10th edit., 1948).
[7] Gram, H. C., and Norgaard, A., *Arch. Int. Med.*, **31**, 164 (1923). Walters, O. S., *Amer. J. Physiol.*, **110**, 37 (1934). Price-Jones, P., Vaughan, J. M., and Goddard, H. M., *J. Path. Bact.*, **40**, 503 (1935). McGeorge, M., *J. Path. Bact.*, **43**, 67 (1936). Donelson, J., Leichsenring, J. M., and Ohlson, M. A., *Amer. J. Physiol.*, **138**, 626 (1943). Lange, H., and Palmer, H., *Acta Med. Scand.*, **127**, 1 (1947).

Reversal of the Heart-beat in Tunicates

The mechanism controlling the periodic reversal of the heart-beat in tunicates is still in dispute. Internal control has been thought to exist, and to be due either to local nerve centres[1], or to physiologically differentiated areas of cardiac muscle[2], at each end of the heart. Evidence from the action of drugs has been conflicting[3]. Hunter[1] found a ring of cells around each end of the heart which he thought to be nerve cells, and Alexandrowicz[4] described nerve fibres but was uncertain whether ganglion cells exist.

I have found rings of fusiform cells in the heart of *Ciona intestinalis* (L) which seem to correspond to those described by Hunter[1], but they are connective tissue cells and not nerve cells, being the ends of sheets of connective tissue that line the large blood vessels at their cardiac junction. Von Skramlik[2] found evidence for the existence at each end of the heart of a small area of cardiac muscle which initiates the beats; alternating dominance of one area over the other would produce periodic reversal. Lahille[5] believed that certain parts of the peripheral system are unable to accept blood as quickly as the heart supplies it, and that the resulting back-pressure that is built up eventually stops the heart. When the heart starts to beat again, it does so in the opposite direction. Haywood and Moon[6] have revived Lahille's theory and from it have formulated an equation relating the time of beating in one direction with the number of beats. In support of the theory they produced experimental results which satisfied the equation, and also they failed to observe reversal of isolated hearts, a phenomenon recorded by von Skramlik[2].

Periodic reversal of isolated hearts, if it could be shown to occur, would be strong evidence against the back-pressure theory, since no such pressure can be built up in a heart not connected with its closed system of vessels. The heart was therefore removed from a number of specimens of *Ciona* and observed continuously for 6–12 hr. It was found that, in most

cases, the newly isolated heart continued to beat in one direction during the first few hours, but eventually reversal started, at first at long intervals but with increasing frequency. The duration, in minutes, of alternate phases in two typical isolated hearts is given, both series being taken about eight hours after isolation. The figures in italic type are for the abvisceral phase, and those in roman type for the advisceral phase.

Specimen 1. *5 6 2 2 4 3 4 3 3½ 3 3 3½ 1½ 2 4½ 3½ 3 3½ 4*
Specimen 2. *1½* 6 *6* 13 *5* 16 *3* 14 *5* 10½ *5* 12 *1½* 14 *12½* 18½ *12* 8 *4½* 10½ *7*

In some of the preparations the wall of the heart was cut open to ensure that the pressures of liquid inside and outside were equal; in others the ends sealed themselves so that a constant pressure was maintained within the heart. In each kind of preparation periodic reversals were made.

The sequence of events during reversal of a weak and slowly beating isolated heart also shows that it is not back-pressure which stops the heart. There is a distinct pause between beats, and very little movement of liquid is produced. Nevertheless, such hearts still reverse, and it can be seen that, immediately before reversal, the hitherto quiescent end starts to beat in opposition to the dominant end, but only takes over control from the latter when, owing to its increasing rate of beat, it initiates a beat before the hitherto dominant end.

I conclude from these experiments that the back-pressure theory is untenable, and that there exists some internal controlling mechanism of the kind described by von Skramlik[2]. Periodic pressure changes may, of course, influence the behaviour of the heart in the intact animal, and may have some effect on the periodicity of reversal; but any such effect is superimposed on the pattern of reversal inherent in the heart.

R. H. Millar

Marine Biological Station,
Millport.
April 30.

[1] Hunter, G. W., *Anat. Anz.*, **21** (1902).
[2] von Skramlik, E., *Z. vergl. Physiol.*, **4** (1926).
[3] Bacq, Z. M., *Bull. Acad. Belg., Cl. Sci.*, (5), **20** (1934). Waterman, A. J., *Physiol. Zool.*, **15** (1942); **16** (1943).
[4] Alexandrowicz, J. S., *Z. allg. Physiol.*, **14** (1913).
[5] Lahille, F., "Contributions à l'étude anatomique et taxonomique des Tuniciers" (Toulouse, 1890).
[6] Haywood, C. A., and Mcon, H. P., *J. Exp. Biol.*, **27** (1950).

Level of National Intelligence

The results of the Scottish Mental Survey[1] presented a paradox which has been difficult to resolve. These results showed a small rise in mean intelligence test score in the eleven-year-old population over a period of fifteen years; but they also established the existence of a negative correlation between intelligence test score and family size—a tendency for intelligent children to be found in small families—which implies the danger of a possible decline in national intelligence, in so far as intelligence is inherited. Though the existence of this negative correlation has now been established, its cause is the subject of considerable controversy, and predictions of the future level of national intelligence depend on how far it can be attributed to a limiting of families by intelligent parents or to the depressive effect of a poor environment on the test scores of children from large families.

The former cause is suggested by the results of previous investigations in which attempts to hold constant such factors as parental occupation or overcrowding in the home have failed to dispel the negative correlation; but such methods are not adequate if the actual size of family is itself an environmental factor—if the lack of adult contact and consequent retardation in verbal development suffered by a child from a large family depress the environmental component of his test score. Such a hypothesis has been shown to be tenable in a survey I have carried out of some 7,600 Aberdeen children; it is consistent with findings in other fields, for example, in the comparison of orphanage children and only children, in studies of bilinguals, deaf children and twins; and model populations can be constructed to show how, on such a hypothesis, the paradox of the Mental Survey results may be resolved, the observed rise being due to improved conditions or to a greater proportion of small families.

While the practice of previous investigators has been to apply one intelligence test to as large a group of children as possible, the method I followed in the Aberdeen survey was to apply several tests with different verbal loadings to the same children. In two groups each of some 2,500 children, aged eleven, the partial correlation between size of family and score in a test of English attainment (with intelligence test score held constant) was negative (about − 0·1) and significant in both groups at the 0·05 level. In a random sample of two hundred children aged eleven, the correlation between size of family and score in the non-verbal Matrices Test was − 0·20, while the correlation between size of family and score in a verbal Moray House Test was − 0·30, the difference being significant at the 0·05 level.

These results support the hypothesis that the environment of the large family constitutes a handicap to verbal development, and that this verbal retardation affects general mental development. If this were so, one would expect the negative correlation between intelligence test score and size of family to be more marked at later ages when the cumulative effect of environment begins to show itself; and this prediction was confirmed with tests applied at different ages. The correlation between intelligence test score and size of family in an age-group of 1,236 children aged seven was − 0·26; in a similar age-group of 1,270 children aged nine it was − 0·29; and in four such age-groups totalling 5,168 children aged eleven it was − 0·33. The difference between the correlation at age seven and at age eleven was significant at the 0·01 level, and was not attributable merely to incomplete families. In a group of 178 children who were tested at ages seven, nine and eleven, confirmatory results were obtained, though the difference between the correlations in this group was not significant because of the small numbers.

The results suggest that part of (but not all) the negative correlation of size of family and intelligence test score, such as was found in the Mental Survey among children aged eleven, may be attributed to the environmental influence of the size of family on verbal ability and through it on general mental development. Fuller details of the results and their analysis will be published elsewhere.

John D. Nisbet

Department of Education,
University of Aberdeen.
May 24.

[1] "The Trend of Scottish Intelligence" (London, 1949).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 17

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Field of Application of Metal Rectifiers" (to be opened by Mr. S. A. Stevens).

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. P. W. Brian: "Microbiology" (Cantor Lectures). (Further Lectures on November 24 and December 1.)

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Lord Rennell of Rodd: "Kimberley Division of Western Australia".

Tuesday, November 18

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Phyllis M. Kaberry: "Gardening and Social Prestige in New Guinea".*

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Dr. J. J. Lehr (Wageningen): "Sodium as a Plant Food".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. Kenneth Hutton: "Intelligence Quotients and Differential Fertility—Some Observations from Winchester College".*

SCHOOL OF PHARMACY, UNIVERSITY OF LONDON (in the Meyerstein Lecture Theatre, Westminster Medical School, Horseferry Road, London, S.W.1), at 5.30 p.m.—Prof. J. W. Cook, F.R.S.: "Organic Chemistry at the Cross-Roads".*

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (joint meeting with the POLYTECHNIC CHEMICAL SOCIETY, at the Battersea Polytechnic, Battersea, London, S.W.11), at 7 p.m.—Dr. H. J. Barber: "The Organic Chemist in Industry".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Direction Finding in Animals" (Chairman: Prof. James Gray, F.R.S.; Speakers: Dr. G. V. T. Matthews (Birds), Dr. H. W. Lissmann (Fish), Mr. D. Wragge Morley (Insects)).

Wednesday, November 19

INSTITUTE OF METALS (at the Royal Institution, 21 Albemarle Street, London, W.1), at 9.45 a.m.—Symposium on "Properties of Metallic Surfaces".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Sir Ronald Fisher, F.R.S.: "The Expansion of Statistics" (Inaugural Address of the President).

ROYAL MICROSCOPICAL SOCIETY (at the Cavendish Laboratory, Cambridge), at 5.30 p.m.—Dr. V. E. Cosslett: "X-Ray Microscopy".

BRITISH ORNITHOLOGISTS' UNION (in the Lecture Hall, British Museum (Natural History), Cromwell Road, London, S.W.7), at 6 p.m.—Annual Scientific Meeting.

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at University College, Gower Street, London, W.C.1), at 6.30 p.m.—Annual General Meeting; The President: "Theory and Practice".

ROYAL METEOROLOGICAL SOCIETY, MIDLAND CENTRE (at the Birmingham and Midland Institute, Paradise Street, Birmingham), at 7.15 p.m.—Mr. H. Shaw: "The Recording of Earthquakes".

Thursday, November 20

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Special General Meeting to consider the Annual Report of Council; Prof. A. J. Kluyver, For.Mem.R.S.: "The Changing Appraisal of the Microbe" (Leeuwenhoek Lecture).

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. J. B. Dennison and Mr. W. W. Varvill: "Prospecting with the Diamond-Drill for Lead–Zinc Ores"; Mr. R. J. M. Dixie and Mr. T. M. Dover: "The Development of Rotary Blast-Hole Drilling in the Jurassic Rocks of Lincolnshire".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Miss Katharine Tousey: "Audubon's America" (colour film); Dr. E. Schelpe: "Vegetation in the Kangra Himalaya" (colour film).

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting; Prof. G. F. S. Temple, F.R.S.: "Theories and Applications of Generalized Functions" (Presidential Address).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. D. H. R. Barton: "The Chemistry of the Steroids". (Further Lectures on November 27, December 4 and 11.)

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. C. A. Cameron-Brown and Mr. P. G. Finn-Kelcey: "Electricity in Farm Crop-Drying".

RESEARCH DEFENCE SOCIETY (in the Physiology Lecture Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Sir Howard Florey, F.R.S.: "The Advance of Chemotherapy by Animal Experiment" (Twenty-first Stephen Paget Memorial Lecture).

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at the Building Centre, Store Street, London, W.C.1), at 6 p.m.—Dr. F. E. Jones: "Alkali-Aggregate Interaction in Concrete".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (joint meeting with the FOOD GROUP, at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.15 p.m.—Discussion on "Technical Problems associated with Microbiological Standards for Foods".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. L. E. Leavy and Mr. C. J. Saunders: "The Design of a Wind Tunnel Balance".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Mr. H. M. Powell: "The Chemistry of Intermolecular Compounds" (Tilden Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at the Liverpool School of Tropical Medicine, Pembroke Place, Liverpool), at 7.30 p.m.—Laboratory Meeting.

Friday, November 21

TEXTILE INSTITUTE (at 10 Blackfriars Street, Manchester), at 3 p.m.—Sir Wallace Akers, F.R.S.: "The Chemical Industry and Textiles".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion on "The Electrical Conductivity of the Upper Atmosphere". (Chairman: Mr. J. A. Ratcliffe, F.R.S.; Speakers: Prof. S. Chapman, F.R.S., Prof. D. R. Bates, Prof. T. G. Cowling, F.R.S.)

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. W. A. W. Fox and Mr. D. Barnett: "The Vertical Reference in Navigation".

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the APPLIED MECHANICS GROUP, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. K. J. B. Wolfe: "Recent Developments in the Machinability of Steel".

ROYAL SOCIETY OF MEDICINE, RADIOLOGICAL SECTION (at 1 Wimpole Street, London, W.1), at 8.15 p.m.—Dr. G. W. Blomfield: "Experience with Two Million Volt X-Ray Therapy and a Preliminary Assessment of Clinical Results"; Dr. J. F. Mitchell: "Experience with 30 MeV. Synchrotron as a Radiotherapeutic Instrument".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. C. T. Wilkins: "The Comet".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

JOINT INTELLIGENCE BUREAU OFFICERS, Grade II, Ministry of Defence (with a university degree, preferably a good honours degree, or equivalent academic qualification or corporate membership of a professional body) for research work of university type on matters of defence interest—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 4169/52 (November 20).

EXPERIMENTAL OFFICER, Grade I, IN THE AERONAUTICAL RESEARCH LABORATORY, Fishermen's Bend, Victoria, to assist in the conduct of flight and laboratory tests on aircraft, to analyse the performance of components, and to prepare and calibrate the necessary equipment—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (November 22).

GRADUATE ASSISTANT SCIENCE MISTRESS at Lady Eldridge Grammar School, South Norwood—The Chief Education Officer, Education Office, Katharine Street, Croydon, Surrey (November 22).

PHYSICIST TO THE RADIOTHERAPY DEPARTMENT—The Secretary, Romford Group Hospital Management Committee, Oldchurch Hospital, Romford, Essex (November 22).

PHYSIOLOGIST (with a good honours degree in physiology or an equivalent qualification, and research experience preferably involving the perfusion of isolated organs) for research on the bovine udder—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 52/11 (November 22).

RESEARCH STUDENT (university graduate, preferably a physiologist) in the Birmingham and Midland Eye Hospital, Birmingham, for work in connexion with hereditary ocular disease—The Secretary, Dudley Road Hospital, Birmingham 18 (November 22).

SCIENTIST, Grade III (with an honours degree in chemistry, with two or three years experience of precise analytical work, and interested in development of new methods of analysis, and investigational and research work), and a SCIENTIFIC TECHNICAL OFFICER, Grade III (qualified N.C. standard, and interested in electronics, workshop practice and general physics)—The Divisional Establishment Officer, National Coal Board, North-Western Division, 40 Portland Street, Manchester 1 (November 22).

SCIENTISTS (with a first- or second-class honours degree in electrical or mechanical engineering, or in physics, and preferably some research experience) for testing, development and research work in the laboratories and in the field in connexion with the generation, transmission and distribution of electricity—The Director of Establishments, British Electricity Authority, British Electricity House, Winsley Street, London, W.1, quoting AE/299 (November 24).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (November 29).

LECTURER IN THE DEPARTMENT OF PHYSICS—The Registrar, University College, Leicester (November 29).

ASSISTANT RESEARCH BIOCHEMIST IN THE SPECIAL UNIT FOR JUVENILE RHEUMATISM, for studies on connective tissue—The Hospital Secretary, Canadian Red Cross Memorial Hospital, Taplow, Maidenhead (November 30).

SCIENTISTS, Grade I (chemists, physicists or, preferably, physical chemists, with not less than a second-class honours degree and a good theoretical knowledge and acquaintance with modern laboratory instruments and techniques) to supervise research on a laboratory scale into known and novel methods of separating coal from shale and other unwanted materials (Ref. TT/559); SCIENTISTS, Grade II/III, with good honours degree, or equivalent, in chemistry, preference being given to physical chemists (Ref. TT/554); SCIENTIFIC TECHNICAL OFFICERS, Grade II/III (chemists or physicists, preferably of degree or H.N.C. standard), to assist in coal carbonization studies and associated analysis of coals, cokes and gases (Ref. TT/555); at the Central Research Establishment, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (December 1).

RESEARCH ASSISTANT (honours graduate in mining or physics) to the Professor of Mining, and a DEMONSTRATOR (graduate in physics or mathematics) IN THE POSTGRADUATE SCHOOL OF MINING—The Registrar, The University, Sheffield (December 6).

PLANT PATHOLOGIST (with a Ph.D. in plant pathology; considerable research experience in the control of diseases of agricultural crops is preferable)—The Secretary, Tobacco Research Board, P.O. Box 1909, Salisbury, Southern Rhodesia (December 15).

PHYSICISTS and CHEMISTS (with good honours degree, or equivalent) at the Central Research Establishment, Stoke Orchard, Cheltenham, for laboratory investigations on the surface characteristics and associated properties of coal and allied materials as applied to briquetting:—SCIENTIST, Grade II, to take charge of the laboratory investigations (Ref. TT/560), a SCIENTIST, Grade III (Ref. TT/561), and SCIENTIFIC TECHNICAL OFFICERS, Grade II (Ref. TT/562)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (December 29).

DEAN OF TRINITY COLLEGE (University of Melbourne)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 30).

BIOCHEMIST in the Clinical Laboratories of the Oldham Group of Hospitals—The Group Pathologist, Department of Clinical Pathology, Boundary Park General Hospital, Oldham.

DEPUTY HEAD OF THE DEPARTMENT OF AIRCRAFT PROPULSION—The Registrar, College of Aeronautics, Bletchley, Bucks.

ENGINEER (Senior Scientific Officer grade) at a Ministry of Supply Experimental Establishment at Christchurch, Hants, dealing with design and development of military bridging and associated equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting E.453/52.

IRRIGATION ENGINEER IN THE WATER DEVELOPMENT DEPARTMENT, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CSD.64/8/02.

PHYSICIST interested in mechanics and engineering, for study and instrumentation of felting machines—The Director, British Hat and Allied Feltmakers' Research Association, Stanley House, Manchester Road, Fairfield, Droylsden, Manchester.

PHYSICISTS or ELECTRICAL ENGINEERS at the Royal Aircraft Establishment, Farnborough: (*a*) in charge of small team developing electronic equipment for guided missiles (Ref. A.281/52A), (*b*) for design and development in physics and engineering fields of guided weapon control, probably involving association with experimental missile trials and with radar and other electronic techniques (Ref. A.282/52A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

RESEARCH ASSISTANT IN THE ELECTRONICS SECTION—The Research Manager, Motor Industry Research Association, Proving Ground, Lindley, Nuneaton.

SCIENCE GRADUATE (preferably in physics) to undertake abstracting of technical literature, preparation of literature surveys and other technical intelligence work—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

SENIOR PHYSICIST TO WORK IN THE SPINNING DEPARTMENT, in the first instance on the physics of the generation of tension in the yarn in ring spinning—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

SENIOR PHYSICIST (with good honours degree plus research experience, and an interest in the application of research to practical problems) for investigations mainly on the elastic and viscous properties of rubbers—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Pitt Rivers Museum: University of Oxford. Occasional Papers on Technology, 5: Pictures of Ivory and other Animal Teeth, Bone and Antler; with a Brief Commentary on their Use in Identification. By T. K. Penniman. Pp. 40+20 plates. (Oxford: Pitt Rivers Museum, 1952.) 10*s.* [307

The Worker's Point of View: a Discussion of 'Reporting Back' based on a Study in a Coalfield. (Nationalized Industry Series 11.) Pp. iv+32. (London: Acton Society Trust, 1952.) 2*s.* [307

Research and Development in British Industry: a Survey of Expenditure on Industrial Research and Development in the Year 1950–51 made by the F.B.I. Industrial Research Committee. Pp. 19. (London: Federation of British Industries, 1952.) 1*s.* 3*d.* [68

Question: a Journal. Edited by H. Westmann. Vol. 4, No. 3: Freedom and Responsibility? By R. H. S. Crossman, the Earl of Verulam, A. E. Cartby and Edwin Barker. (Published for the Present Question Conference, Ltd.). Pp. 217–304. (London: Hammond, Hammond and Co., Ltd., 1952.) 2*s.* 6*d.* [138

A Guide to Blakeney Point and Scolt Head Island. Edited by Prof. J. A. Steers. Pp. 56+12 plates. (London: National Trust, 1952.) 3*s.* 6*d.* [198

Bulletin of the British Museum (Natural History). Geology, Vol. 1, No. 7: A New *Trochiliscus* (Charophyta) from the Downtonian of Podolia. By W. N. Croft. Pp. 187–220+plates 18–19. (London: British Museum (Natural History), 1952.) 10*s.* [198

Department of Scientific and Industrial Research: Food Investigation. Special Report No. 56: The Dehydration of English Fruit. By Dr. C. West, Dr. A. C. Hulme, C. R. Furlong and G. H. Crouch. Pp. iii+42. (London: H.M. Stationery Office, 1952.) 1*s.* 6*d.* net. [198

Register of Research in the Social Sciences in Progress and in Plan. No. 9, 1951–1952, with a Directory of Research Institutions. Editor: Feodora Stone. Prepared at the National Institute of Economic and Social Research. Pp. 188. (London: Cambridge University Press, 1952.) 15*s.* [198

General Register Office. The Registrar General's Quarterly Return for England and Wales. No. 413: Births, Deaths and Marriages, Infectious Diseases, Weather, Survey of Sickness, Population Estimates; Quarter ended 31st March 1952. Pp. 48. (London: H.M. Stationery Office, 1952.) 2*s.* 6*d.* net. [198

Council for the Preservation of Rural England. Annual Report, 1951–52. Pp. 50+4 plates. (London: Council for the Preservation of Rural England, 1952.) [198

Other Countries

Bulletin of the Museum of Comparative Zoology. Vol. 106, No. 10: Foraminiferal Distribution in the Long Island Sound—Buzzards Bay Area. By Frances L. Parker. Pp. 425–474+plate 5. Vol. 106, No. 11: Revisionary Studies of some South American Teiidæ. By Rodolfo Ruibal. Pp. 475–530. (Cambridge, Mass.: Harvard College, 1952.) [307

Smithsonian Institution: Bureau of American Ethnology. Bulletin 147: Journal of an Expedition to the Mauvaises Terres and the Upper Missouri in 1850. By Thaddeus A. Culbertson. Edited by John Francis McDermott. Pp. viii+164. 75 cents. Bulletin 148: Arapaho Child Life and its Cultural Background. By Sister M. Inez Hilger. Pp. xv+253+40 plates. 75 cents. (Washington, D.C.: Government Printing Office, 1952.) [307

Bulletin of the American Museum of Natural History. Vol. 99, Article 3: The Problem of Land Connections across the South Atlantic, with Special Reference to the Mesozoic. By Ernst Mayr (Editor), Maurice Ewing, Walter H. Bucher, Kenneth E. Caster, Carl O. Dunbar, Marshall Kay, George Gaylord Simpson, Daniel I. Axelrod, Theodor Just, Wendell H. Camp, P. J. Darlington, Jr., Alfred E. Emerson, Bobb Schaeffer, David H. Dunkle, Edwin H. Colbert and Alfred S. Romer. Proceedings of the Symposium on 'The Role of the South Atlantic Basin in Biogeography and Evolution' held at the Fourth Annual Meeting of the Society for the Study of Evolution, New York City, December 28 and 29, 1949. Pp. 79–258+2 plates. (New York: American Museum of Natural History, 1952.) 3 dollars. [307

Beach Erosion Board: Corps of Engineers. Technical Memorandum No. 27: Wind Set-up and Waves in Shallow Water. By Thorndike Saville, Jr. Pp. iv+36. (Washington, D.C.: Government Printing Office, 1952.) [307

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjärde Serien, Band 3, No. 1: Recent Lymnaeidae; their Variation, Morphology, Taxonomy, Nomenclature and Distribution. By Bengt Hubendick. Pp. 223+5 plates. 25 Kr. Fjärde Serien, Band 3, No. 2: Kolchizininduzierte Heteroploidie beim Schwein. Von Gösta Häggqvist und Allan Bane. Pp. 14. 2.25 Kr. (Stockholm: Almquist and Wiksell; London: H. K. Lewis and Co., Ltd., 1951.) [317

Commonwealth Observatory, Canberra. Report of the Commonwealth Astronomer for the Year 1950. Pp. 5. Supplement to the Report of the Commonwealth Astronomer for the Year 1950. Pp. 11+7 plates. Report of the Commonwealth Astronomer for the Year 1951. Pp. 5. (Canberra: Commonwealth Government Printer, 1951–1952.) [317

Commonwealth Observatory, Canberra. Memoir No. 11: Solar Radiation Observations on Mount Stromlo, 1927–1939. By W. B. Rimmer and C. W. Allen. Pp. 42. (Canberra: Commonwealth Government Printer, 1950.) [317

Beihefte zum Geologischen Jahrbuch. Heft 3: Monographien der Deutschen Blei-Zink-Erzlagerstätten, Monographie 1, Die Blei-Zink-Erzverkommen des Ruhrgebietes und seiner Umrandung. Von Friedrich Buschendorf, Julius Hesemann, Andreas Pilger und Max Richter. Lieferung 1. Pp. viii+184+18 plates. (Hannover: Amt für Bodenforschung, 1951.) 20 D. marks. [188

Ceylon. Part 4: Education, Science and Art (L). Administration Report of the Acting Director of Fisheries for 1951. By E. R. A. DeZylva. Pp. L.30. (Colombo: Government Publications Bureau, 1952.) 10 cents. [198

Bulletin of the World Health Organization. Supplement 4: Comparability of Statistics of Causes of Death according to the Fifth and Sixth Revisions of the International List. Pp. 59. (Geneva: World Health Organization; London: H.M. Stationery Office, 1952.) 2*s.* 9*d.*; 50 cents; 2 francs. [198

Catalogues

Osram Lamps in the Making. Pp. 24. (London: General Electric Co., Ltd., 1952.)

Michrome Biological Stains and Reagents. Pp. 42. (London: Edward Gurr, Ltd., East Sheen, 1952.)

Sunvic Boiling Plates. (Publication BP.10a.) Pp. 4. (London: Sunvic Controls, Ltd., 1952.)

'Speedivac' Pumping Units for Pipeline Vacuum Systems. (A.106/3.) Pp. 4. High Pressure Compressors and Vacuum Pumps. (A.111/2.) Pp. 2. 'Speedivac' Physics Educational Equipment Models EQ1 and EQ2. (A.116/1.) Pp. 6. Circseal Precision Glass Cone Joints for High Vacuum. (C. 103/1.) Pp. 2. Vacuum Pumping Outfits. (E.112/1.) Pp. 6. (London: W. Edwards and Co. (London), Ltd., 1952.)